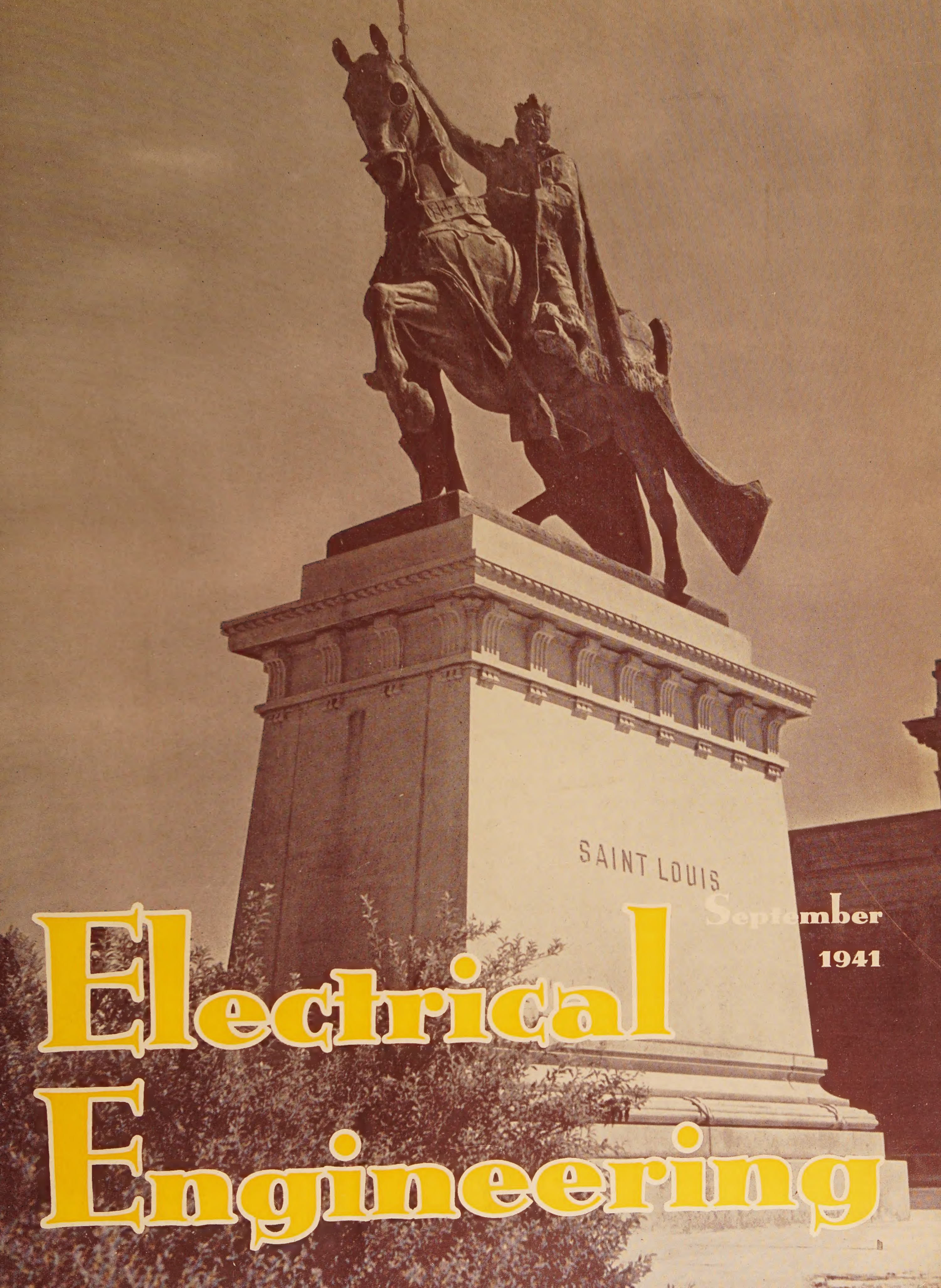
AIEE South West District Meeting, St. Louis, Mo., October 8–10, 1941



Electrical Engineering

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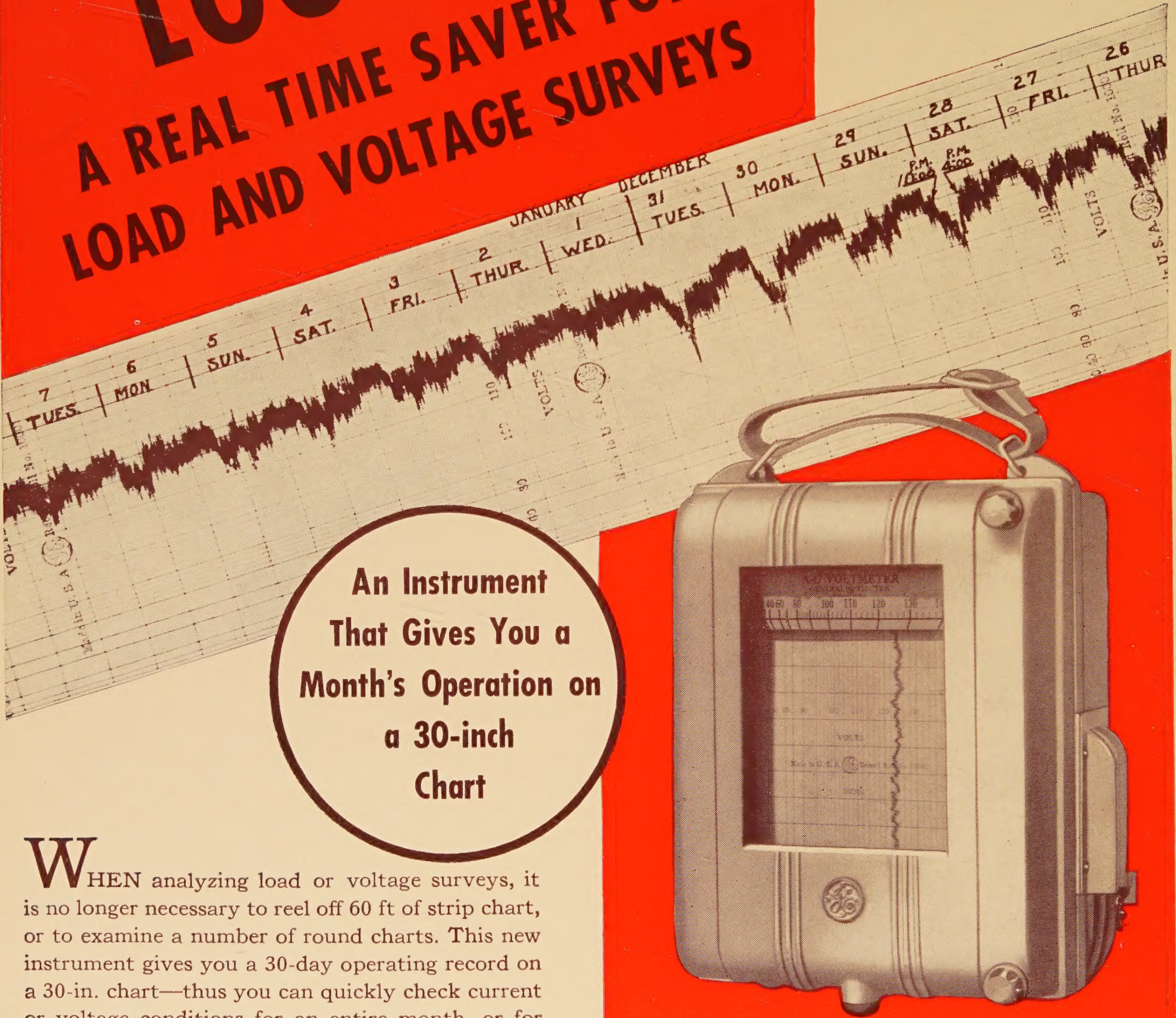

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Electrical Engineering

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for September 1941—

The Cover: The equestrian statue of Saint Louis stands in front of the Art Museum in St. Louis, Mo., where the AIEE South West District meeting is to be held October 8–10, 1941

Photo courtesy St. Louis Chamber of Commerce

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High Lights • •

Application of Interrupting Devices. The method of calculating system short-circuit currents developed by the AIEE subcommittee on circuit breakers, switches, and fuses consists of determining the highest value of symmetrical short-circuit current for any type of fault as obtained by dividing voltage by subtransient reactance, and assigning multiplying factors according to the basis of rating and speed of operation of the equipment concerned (*Transactions pages 877–81*). To facilitate the use of this method in the application of circuit breaker, the short-circuit ratings of breakers should be correlated so that a breaker selected for adequate interrupting capacity automatically has ratings adequate for other related requirements (*Transactions pages 882–4*).

Lightning Protection. The combination of overhead ground wires, transformer-mounted arresters, and line entrance gaps that has been found to provide effective protection from direct lightning strokes for high-voltage high-capacity stations usually is not economical for stations on subtransmission systems where wood insulation is employed throughout; for these a high degree of protection can be achieved by the use of a reactor to compensate for the "turn-up" of the gap. (*Transactions pages 898–900*).

Fires of Electrical Origin. Between one-third and one-half of the fires of electrical origin reported to a large group of industrial fire-insurance companies are estimated to have been caused by poor maintenance of electrical equipment. With industrial production increasing at its present accelerated rate, under impetus of the National Defense Program, it is doubly important that this equipment be given the care that it merits, if a sharp increase in the proportion of electrical fires is to be averted (*pages 428–31*).

The Metering Art. The origins and progress to date of the art of metering electric energy have been made the subject of a historical survey undertaken under the direction of the AIEE committee on instruments and measurements. Ultimately to be published in pamphlet form, the report is being presented in four parts in this and subsequent issues of ELECTRICAL ENGINEERING; the first part deals with origins and pioneers (*pages 421–7*).

Insulation Testing. Nondestructive testing of insulation depends for success upon satisfactory correlation between dielectric strength and low-frequency interfacial polarization in insulation, which has been shown to exist because of their mutual dependence upon the abundance and disposition of free electrons and ions throughout the material (*Transactions pages 890–5*).

Industrial Network System. The industrial distribution system recently installed in an extension brought about by war-time expansion of a Canadian plant employs a development of the primary network principle rather than the conventional metropolitan type of network; functioning and cost of the two systems have been compared (*Transactions pages 862–5*).

Lightning Records. Oscillographic records of the wave shapes of natural lightning to the Empire State Building in New York, N. Y., were obtained in sufficient number during the summer of 1940 to make possible determination of frequency of occurrence of various rates of rise, crest currents, duration, and charge (*Transactions pages 885–90*).

Canadian Broadcasting. Under the control of the Canadian Broadcasting Corporation, which operates a nation-wide network in addition to its regulatory function, development of radiobroadcasting in Canada has been rapid; the system in practice is one of co-operation between a semipublic service and private ownership (*Transactions pages 896–8*).

Shielding Magnets. Forged steel magnets in watt-hour meters can be protected from the effects of transient magnetic fields by shielding with a thick copper coating applied by a new high-speed process; with this method of protection shielded and ununshielded magnets are interchangeable (*Transactions pages 875–7*).

Oil for Circuit-Breaker Testing. Results of tests made by an AIEE working group to determine the minimum dielectric strength of oil for high-voltage circuit-breaker testing have been used as a basis for recommendations on the strength of oil for that purpose (*Transactions pages 903–06*).

Measuring Lightning Surges. The second of a series of three articles on lightning phenomena describes several special instruments that have been devised to secure for power-system engineers the information they must have to provide protection for the system (*pages 438–43*).

Branch Prize Paper. The AIEE national prize for Branch paper, for student papers presented during the year ending June 30, 1940, was awarded for a paper describing a stabilized neon-tube direct-coupled amplifier; an abstract appears in this issue (*page 437*).

Bus Protection. Standard high-speed directional and plunger-type relays of simple design provide the basis for a method of bus protection that requires neither matched current transformers nor insulation of all equipment from ground (*Transactions pages 859–62*).

Frequency Meter. Use of an iron-core cross-coil dynamometer eliminates the external reactor in a recently developed frequency meter. Compactness and lack of auxiliary equipment should make this instrument particularly valuable where space is limited (*Transactions pages 866–9*).

Life of Cold-Cathode Tubes. Experiments have proved that the life of cold-cathode tubes is determined solely by the current drawn. The establishment and application of a law of relationship between tube life and current drain are discussed (*Transactions pages 901–03*).

Mechanism of Air-Blast Breakers. Air-blast circuit breakers with voltage ranges from 4 to 230 kv have been described and the sequence of operations of three distinct types outlined in detail (*Transactions pages 869–74*).

Freon as an Insulating Medium. Tests have been made to see to what extent the chemical disintegration of Freon in the presence of corona and spark-over limits its use as a practical insulating medium for high-voltage equipment (*pages 435–6*).

High-Speed Radiography. With the recent development of a cold-cathode X-ray tube, radiographs can be made at speeds of about one microsecond, thus recording on film the distortion occurring inside objects opaque to visible light (*pages 432–5*).

Officers and Committees. National officers and committees chosen to serve the Institute during the year 1941–42 are listed in this issue; as are Section and Student Branch officers (*pages 453–7*).

Coming Soon. Among special articles and technical papers currently in preparation for early publication are: an article on developments in electric metering since 1900, the second part of the progress report sponsored by the AIEE committee on instruments and measurements; an article on field studies of lightning, the third and final part of the series on lightning phenomena by C. F. Wagner (F'40) and G. D. McCann (A'38); an article on styrene and its insulation potentialities by T. R. Scott; a paper on bushing tests by A. L. Brownlee (A'25) and W. H. Wickham (A'41); a paper describing the a-c dielectric-loss and power-factor method for field investigation of electrical insulation by F. C. Doble (A'12); a paper on impulse strength as a measure of cable quality by L. I. Komives (A'41); a paper on damping and synchronizing torque of the double-fed asynchronous machine by M. M. Liwschitz (M'39); a paper on excitation circuits for ignitron rectifiers by H. C. Myers and J. H. Cox (A'25); a paper on the protection of solid insulation by lightning arresters by D. D. MacCarthy (A'28) and T. J. Carpenter (A'38); a paper on the measurement of body currents by Doctor Robert S. Schwab; a paper on the theory of torsional dampers as applied to the reduction of conductor vibration by J. M. Speight; a paper describing a new transformer for base-load stations by Philip Sporn (F'30) and H. V. Putman (M'32); a paper on the relative accuracy of three-phase metering combinations by C. T. Weller (M'21); a paper describing a simple method for determining ratio error and phase angle in current transformers by E. C. Wentz (A'28).

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Progress in the Art of Metering Electric Energy

I—Origins

This first article in a series of four on the historical background of the metering art, sponsored by the AIEE committee on instruments and measurements, deals with origins and development up to 1900; the others, covering respectively (II) progress in the art from 1900 to 1925, (III) special applications, and (IV) calibration and installation of meters, will appear in future issues

AN INDUSTRIAL ART is the adaptation through change or combination of material things both new and old to the accomplishment of some desired end. An essential ingredient is skill.

Progress in an art is the integrated result of three major influences. First and most vital, there are the men who for one reason or another have become so deeply interested in accomplishing a given result that there is created a reservoir of human ingenuity sufficient to insure success. Second, there are the technological discoveries in other fields which give these men new materials, tools, and methods by means of which progress in their own art is accelerated. Third, there are the sociological trends, economical, political, and otherwise, which are largely responsible for charting the course to be followed.

There is probably no better example of the working of these forces than the creation and subsequent progress of the art of metering electric energy.

In the year 1879, through the genius, initiative, and industry of Thomas A. Edison, the incandescent electric lamp became a commercial reality. Three years later, on September 4, 1882, Edison put in operation the Pearl Street generating station in New York City.

Because of vigorous opposition on the part of the then predominating gas interests, and the great difficulty of interesting capital in the new enterprise, the development of this industry which today has become almost indispensable to human welfare, might have been greatly retarded. That it was not so retarded is due, in part at least, to the invention of a new art—the art of metering electric energy. Edison himself realized, probably earlier than anyone else of that time, the necessity for a meter to measure the commodity that he proposed to sell, and was the first to develop and make available a commercial measuring device for this purpose.

An early form of Edison's meter is shown in figure 1*a*. This meter is technically an electrolytic-deposit meter, but it is known to the industry as Edison's "chemical meter". Just as the first automobiles took on the physical form of horse-drawn carriages, so Edison's meter borrowed from the common method of selling commodities and measured electricity by the ounce.

His meter consisted of a jar containing an electrolyte in which two metal electrodes were submerged. A known proportion $\left(\frac{1}{974}\right)$ of the electrical current was made to flow between the two metal electrodes. Over a period of time the weight of metal transferred electrolytically from one electrode to the other was proportional to the amount of electricity (ampere-hours) that had passed through the meter in that period. Therefore, to "read" this meter it was necessary to weigh the electrodes at the beginning and at the end of the billing period. From the decrease in weight of one of the electrodes it was possible to calculate the ampere-hours of electricity used by the customer.

This meter obviously was not a true energy-measuring device, since the amount of metal transferred from one electrode to the other was independent of the voltage of the system. Furthermore, the accuracy of this meter was affected by variations in the temperature of the electrolyte. Consequently a copper coil was placed in series with the jar to compensate for the temperature coefficient of resistance of the electrolyte and thus make the total temperature coefficient of the branch circuit equal to that of the German-silver shunt. In addition to this copper coil there was sometimes another coil operated by a thermostat, primarily to prevent the electrolyte from freezing. Later, because of the change to alternating current on most systems, the fact that this meter would not operate on that type of current was a disadvantage.

Operating troubles were both more varied and more numerous. Removing the electrodes and weighing them presented many difficulties to the meter "reader", called in

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This report was initiated and sponsored by the AIEE committee on instruments and measurements as part of its regular activities for 1940–41, under the following direction: I. F. Kinnard, West Lynn, Mass., chairman; A. S. Albright, Detroit, Mich., vice-chairman; T. S. Gray, Cambridge, Mass., secretary. **Personnel of subcommittee on watt-hour meters:** A. S. Albright, chairman; D. T. Canfield, Lafayette, Ind., editor-in-chief; A. L. Brownlee, Chicago, Ill.; A. B. Craig, Boston, Mass.; J. S. Cruikshank, Baltimore, Md.; C. L. Dawes, Cambridge, Mass.; A. P. Good; Stanley Green, Lafayette, Ind.; F. C. Holtz, Springfield, Ill.; H. C. Koenig, New York, N. Y.; Paul MacGahan, Newark, N. J.; C. V. Morey, New York, N. Y.; H. C. Rankin, Boston, Mass.; A. R. Rutter, Newark, N. J.; F. B. Silsbee, Washington, D. C.; G. R. Sturtevant, Lynn, Mass.; and H. L. Thomson, Hartford, Conn.

Following publication of part IV in ELECTRICAL ENGINEERING, the whole report will be issued in pamphlet form.

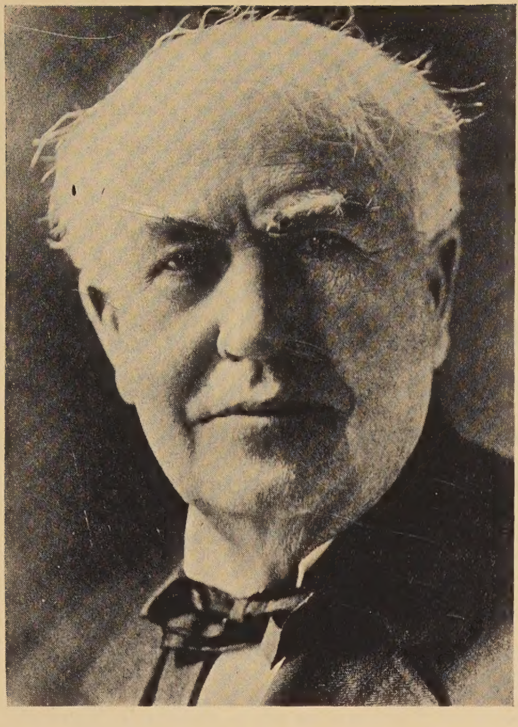


Figure 1b (left). Thomas A. Edison

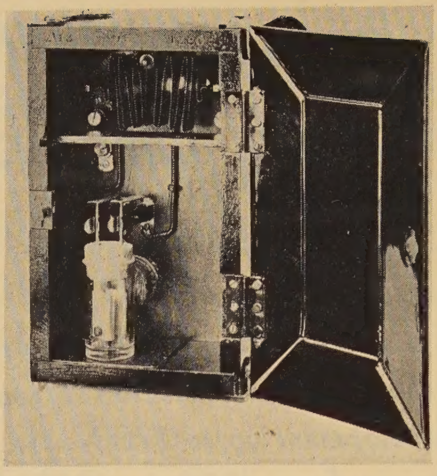


Figure 1a. Edison chemical two-wire meter

those days a "calculator". The meter was not, in other words, self-indicating. The customer could not read his own meter. It is interesting to note in an early report of the meter committee of the Association of Edison Illuminating Companies that considerable space was devoted to ways and means of fostering customer good will. One suggestion was that the electrode plates be weighed in the presence of the customer.

By the close of the first decade in metering progress, ending in 1890, the human ingenuity applied to the metering art had been greatly augmented. The next man to make a great and lasting contribution to the measurement of electric energy was Professor Elihu Thomson, co-founder of the Thomson-Houston Electric Company at Lynn, Mass., which later became the nucleus of the General Electric Company. Of many meters invented by Thomson, the one that had the greatest influence upon the metering art, is shown in figure 2*b*. This meter, first manufactured in 1889, was a true energy-measuring device, probably the first to be used commercially in America. It was first known as the "TRW" meter, meaning Thomson recording wattmeter; then as the "mechanical meter" to differentiate it from Edison's chemical meter, and the "universal meter" since it was used extensively on both a-c and d-c systems; and finally as the "Thomson watt-hour meter". This meter was, in effect, a small shunt motor, with the field or current coils of heavy wire connected in series with the line, and the armature of fine wire connected across the line. The currents in the two windings were proportional to the line current and voltage respectively, and the torque of the motor, therefore, was proportional to the power. The braking or retarding mechanism consisted of a copper disk mounted on the armature shaft which was caused to rotate between the poles of three permanent magnets clamped to the bottom of the base. Since the magnetic braking torque varied directly with the speed, the number of revolutions of the meter in a given period became a measure of the amount of energy passing through the meter during that period. The meter had a set of dials upon which the result of this action was recorded.

Although Professor W. E. Ayrton in England appears to be the first to have conceived the idea of controlling the speed of a motor meter by utilizing the action of a permanent magnet flux upon a damping disk, Thomson first applied the principle to make a commercially successful meter.

Thomson's meter overcame most of the technical and all of the operating difficulties of Edison's chemical meter. Although its accuracy was not up to our modern standards, it was remarkable for a meter of any kind in the late 1880s. It rapidly became the recognized standard instrument for the measurement of d-c energy. The most significant fact about this meter is that the basic principle of its operation, perfected by Thomson more than 50 years ago, is used today without change in all d-c commutator-type motor meters of whatever manufacture.

Between 1890 and 1900 Thomson and W. H. Pratt made many basic improvements in this meter. The original cast-iron bases were replaced by bases made of a nonferrous metal. This change improved the meter's performance, particularly on direct current. Fixed coils in series with the armature and arranged to augment the field in which the armature operated appeared early in the development. These coils, called at that time "starting coils," were the first devices aimed at compensating the meter for friction. The adjustable form of this coil appeared first about 1900. Also at this time, direct-reading registers (those not requiring multipliers) became more or less standard and shortly thereafter the first anticreeping device was added. The term "creep" as applied to watthour meters refers to the tendency of the meter disk to rotate under "no load" conditions. Creeping is a result of the addition of compensating means of various kinds to meters to improve their starting performance and to improve accuracy at light load. The first anticreeping device consisted of a piece of steel wire clipped over the edge of the disk. The tendency to creep was stopped when the clip was brought within the field of the permanent magnets by rotation of the disk. This device was first used by F. G. Vaughen in 1901.

The technological developments that influenced the invention of a meter strictly for alternating current were the enunciation of the principle of the revolving magnetic field by Galileo Ferraris of Turin, Italy, in 1885; the invention of the transformer by Lucien Gaulard and John D. Gibbs about 1882 and its perfection and adaptation in America by William Stanley in 1886; and the invention of the induction motor by Nikola Tesla in 1887. Briefly, the principle enunciated by Ferraris was that to produce a torque or force on an armature free to rotate, it must be acted upon by two alternating current fluxes which are: (1) not in time phase with each other, and (2) applied to the armature in two different places along the direction of proposed motion. The inventions of the transformer and the induction motor are significant because they made possible the a-c system and thereby greatly stimulated the effort to provide meters for alternating current only.

The result of these influences upon the art under discussion was the development of a meter operating exclusively on alternating current, invented by Oliver B. Shallenberger, who at that time was a design engineer with George Westinghouse, founder of the Westinghouse Electric and Manufacturing Company, at Pittsburgh, Pa.

Shallenberger's a-c meter is shown in figure 3*a*. It was not a watt-hour meter, but an ampere-hour meter. The patent issued to Shallenberger covering this meter was granted in 1888. It included at least the basic principles of an a-c watt-hour meter. Shallenberger was apparently of the opinion that the simpler ampere-hour meter would be in more demand at that stage of the art than the more complicated watt-hour meter and therefore the former was put in production first. This ampere-hour meter had but one pair of coils through which the line current passed. A second pair of coils at an angle with but in close proximity to the current coils received energy by induction from these coils. The disk or revolving element of the meter was placed inside both pairs of coils. Air-vane braking was used. At the relatively low speeds at which the meter operated, the braking torque was proportional to the square of the speed. Thus the number of revolutions made by the meter in a given period was made proportional to the ampere-hours passing through the meter during that period.

The simplicity and low cost of Shallenberger's meter caused the operators to adopt it with alacrity for a-c circuits. However, as the use of alternating current increased, the fact that Shallenberger's meter measured ampere-hours and not watt-hours created a preference for Thomson's meter.

The sociological trends as gleaned from the reports of meter committees of the period indicate that the requirements of the central-station industry had far outstripped the availability of meters and large amounts of electric energy were being sold on a "per lamp" basis. By the end of the decade 1880–90 all such committees were definitely recommending that this practice be stopped, and that in all large cities, at least, meters be used. This decision to substitute a metered rate for the flat rate then prevalent was brought about largely by the availability of Thomson's and Shallenberger's meters.

The final stage in the origin of the art of metering was reached in the decade between 1890 and 1900. Although other interests had claimed Edison's attention and he was no longer actively interested in meters, the factor of human skill was increased by the work of Thomas Duncan and Robert C. Lanphier. The former founded the Duncan Electric Company at Lafayette, Ind., in 1901, and the latter was a major influence in the founding of the Sangamo Electric Company at Springfield, Ill., in 1899.

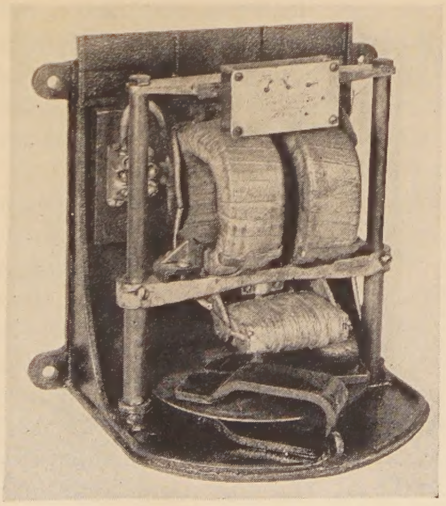
At the time under discussion (1890) Duncan was designing meters for the Fort Wayne Electric Light Company at Fort Wayne, Ind. An early meter manufactured by this company is shown in figure 4*a*. It was known as the Duncan Fort Wayne meter. It was an ampere-hour meter and was identical in principle of operation with Shallenberger's meter, differing only in the physical form and arrangement of its component parts. It carries a patent date of 1894.

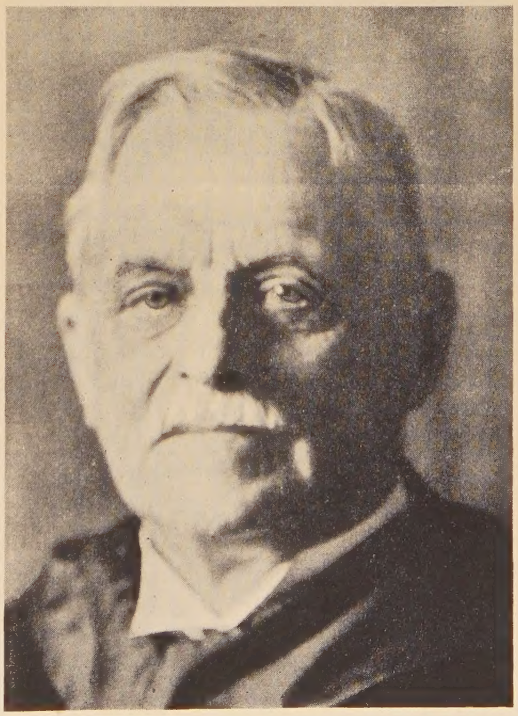
Lanphier entered the metering art in the fall of 1897, soon after his graduation from Yale, through a chance meeting with Jacob Bunn, Jr., vice-president of the Illinois Watch Company. Bunn persuaded Lanphier to undertake certain experiments on a meter designed by a German inventor, L. Gutmann. On September 13, 1897, Lanphier reported for work and was given space in an unused outbuilding of the Illinois Watch Company. This was the beginning of the Sangamo Electric Company, the subsequent contributions of which rank it among the leading meter manufacturers of today. An early Gutmann meter is shown in figure 5*b*. These meters were the first manufactured by the Sangamo Electric Company.

About the middle of this decade occurred the greatest

Figure 2a (right). Professor Elihu Thomson

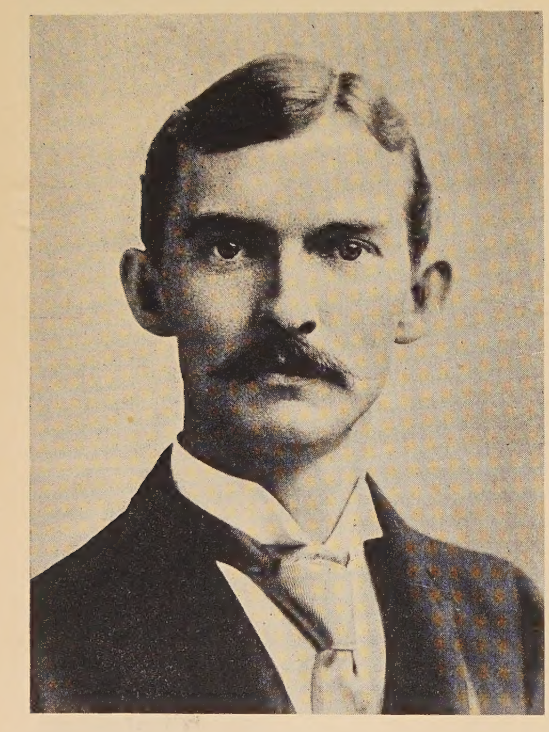
Figure 2b. First commercial "Thomson recording wattmeter" manufactured by the Thomson-Houston Electric Company, September 18, 1899





single technological discovery or invention ever made in the art of metering electric energy. If one may liken an electric meter to the human body, this discovery was its heart. The man who made this vital contribution was Oliver B. Shallenberger, who discovered how the induction meter, which recorded ampere-hours, could be made to record watt-hours or energy. To the initiated in the profession of metering, the method he discovered is known as the lagging process.

To understand the exact nature of this process it must be realized that an instrument which is ultimately to record energy must first produce on the moving element a torque or force which is at all times proportional to the power flowing in the circuit to be measured. The first step in the accomplishment of this result is that there be at least two coils. One coil is connected across the circuit in such a manner that the flux created by it is proportional to the voltage and the other is connected in series with the circuit so that the flux created thereby is proportional to the current flowing in the load. Shallenberger pointed out that if the combination of these two fluxes upon a rotatable member is ever to produce a force on that member proportional to power the flux produced by the potential coil must be caused to lag in time behind the voltage of the circuit by exactly one quarter of a cycle. He produced this desired time relation by means of a lag coil placed on the potential-coil pole.



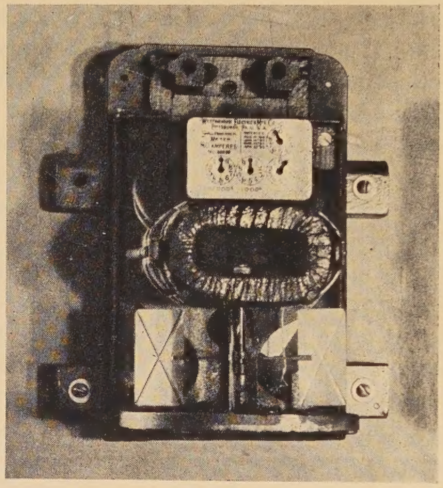


Figure 3a. Shallenberger ampere-hour meter

Figure 3b (left). Oliver B. Shallenberger

For those not familiar with the art, it is sufficient to realize that this lagging process is absolutely essential whenever a-c energy is to be measured correctly by an induction-type meter.

Figure 6 shows the four watt-hour meters which, with but slight use of poetic license as to time and place, can be said to be the start of nearly 50 years of progress in the art of metering electric energy. Meter (*a*) is an early model of Shallenberger's first watt-hour meter. It was offered for sale in 1894 for approximately $15. It was a true energy-measuring meter of the induction type, and the first to be placed in commercial use in this country.

Meter (*b*) is the result of basic design work by Thomson and Pratt, and appeared on the market in the fall of 1897. It was the first induction-type watt-hour meter produced by the General Electric Company and superseded the commutator-type Thomson watt-hour meter of 1889 for a-c service.

Meter (*c*) is an experimental model of a watt-hour meter designed by Thomas Duncan about 1892. It is probably the first use of a single disk in a meter of this type. It is not a commercial meter, and never appeared on the market.

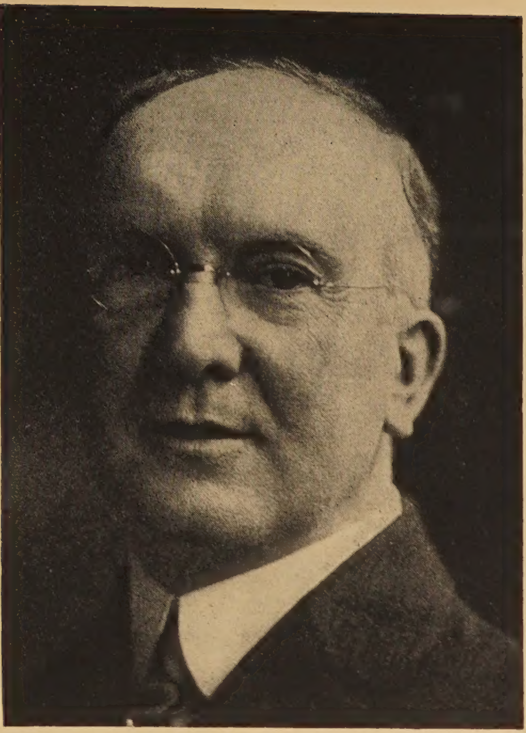
Meter (*d*) was designed by Gutmann and manufactured by the Sangamo Electric Company. The first shipment of these meters was made in 1899. The Gutmann meter had a rather short life, owing to patent difficulties, but it was the first watt-hour meter to be manufactured by the Sangamo Electric Company.

The Gutmann meter is of particular interest to the student of the art because of the ingenious method employed in an attempt to avoid infringement of the Tesla patents. Gutmann mounted his potential and current electromagnets so that there was no space displacement between them in the direction of proposed motion of his moving element. This space displacement is an essential element as Ferraris' original statement shows. Gutmann obtained the essential space displacement by cutting spiral slots in his armature, thereby causing the induced current to move sidewise.

By the end of the decade, at least two other meters were on the market, one by G. A. Scheeffer and another by Stanley. The Diamond meter of this period, and the Columbia, Holcomb and Hoke, and Sewickley meters of a later period were all of Scheeffer design. Scheeffer was active in the art from about 1895 to 1920.

Stanley's work in meters is of particular interest because he was the inventor of the magnetic flotation meter. This meter had no bearings as such. The disk was suspended or floated in the magnetic flux. It was held in place by a wire thread through a hollow shaft and a hub. Such a principle required very large fluxes and the first meters could be built only for large current ratings.

The record would hardly be complete if mention were not made of one other type of meter—the Faraday disk or mercury-motor type of quantity meter. This principle



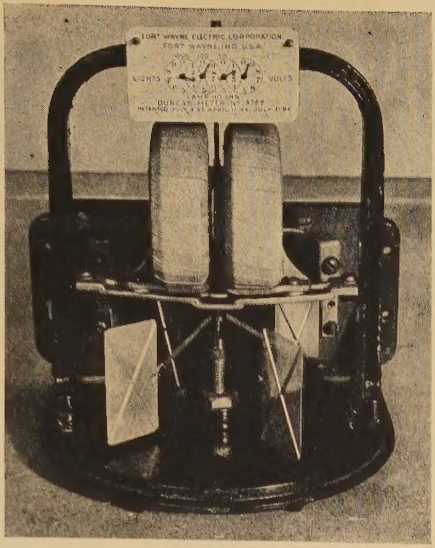


Figure 4a. Duncan Fort Wayne ampere-hour meter

Figure 4b (left). Thomas Duncan

seems to have been embodied first in a meter by George Hookham and S. F. de Ferranti in England about 1888. Rotation of a copper disk partly or wholly submerged in mercury was produced by the interaction of a suitable permanent magnet with an electric current through the disk. In the United States the fundamental discoveries of E. S. Halsey of the General Electric Company were instrumental in increasing the efficiency of the mercury meter and making it a practical device. However, Lanphier of the Sangamo Electric Company is entitled to much of the credit for the early practical application of this meter.

Figure 7 shows the three meters just discussed. Meter (*a*) is an early meter by Scheeffer which was built by the Diamond Meter Company at Peoria, Ill. Meter (*b*) is one of Stanley's magnetic flotation meters manufactured at Great Barrington, Mass. Meter (*c*) is an early mercury meter by Lanphier, a product of the Sangamo Electric Company.

Admittedly, the four meters with which progress in the art of metering electric energy started were crude, inefficient devices needing constant attention to keep them operating with even reasonable accuracy, but similar difficulties are encountered in the early stages of any art.

Probably no one realized the need of improvement to a greater extent than did the operators themselves at the turn of the century. It is instructive in this respect to read the minutes of some of the early meter committees of the Association of Edison Illuminating Companies. In this way may best be understood the trend that early progress was to take. Among the members of this committee were J. W. Lieb, New York Edison Company, L. A. Ferguson, Chicago Edison Company, and Alex Dow, Detroit Edison Company.

In 1899 these men were asking for "a meter having light load adjustable for local conditions; hence a meter which will not creep, and will yet be accurate on light loads; a meter which will be unaffected by short circuits; a meter which will be substantially dust proof, and which will have outside binding posts." And again "A meter that can be shut up and let alone and which it would not be necessary to clean and adjust every six months would be an improvement, and we think that the matter still requires study and action."

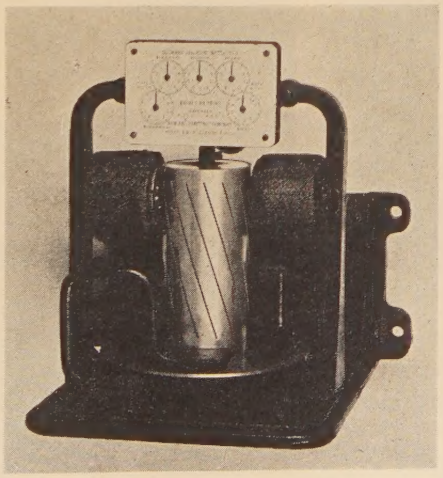
Finally one notes that these more or less general requests made in the spirit of hopefulness, and no doubt without much expectancy of immediate fulfillment, were instantly accepted by the various manufacturers. Their engineers reported back to the committee that the following improvements would be undertaken.

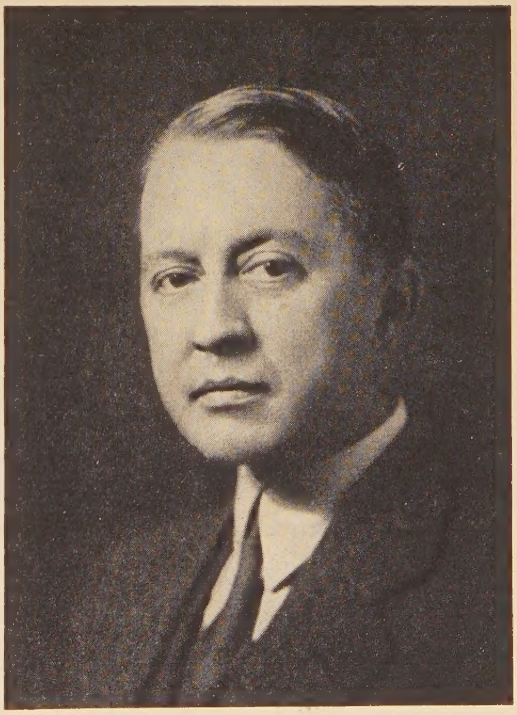
"First, a dust and insect-proof cover.

"Second, a cover and frame so shaped and retained together as to

Figure 5a (right). Robert C. Lanphier

Figure 5b. An early Gutmann a-c watt-hour meter



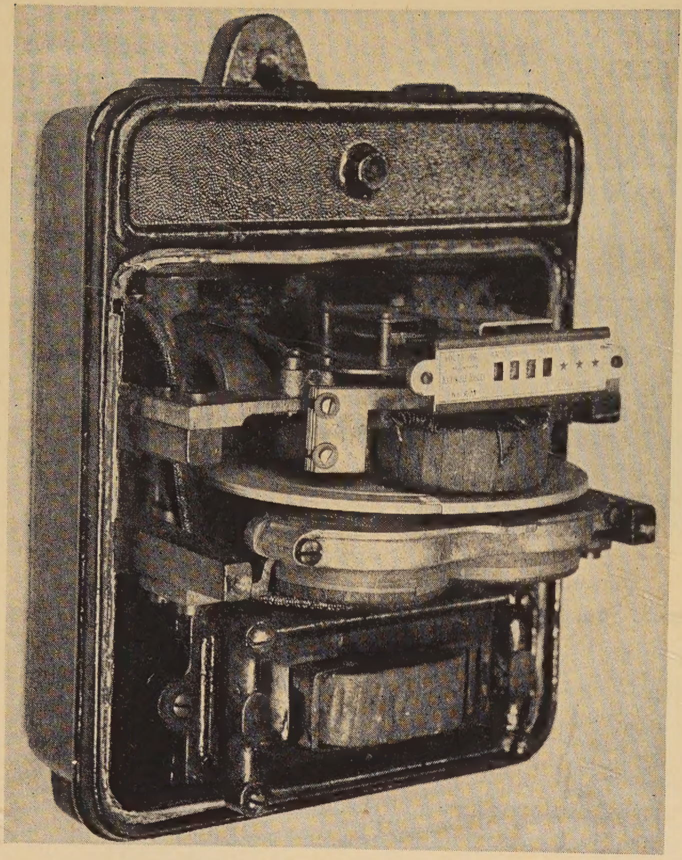


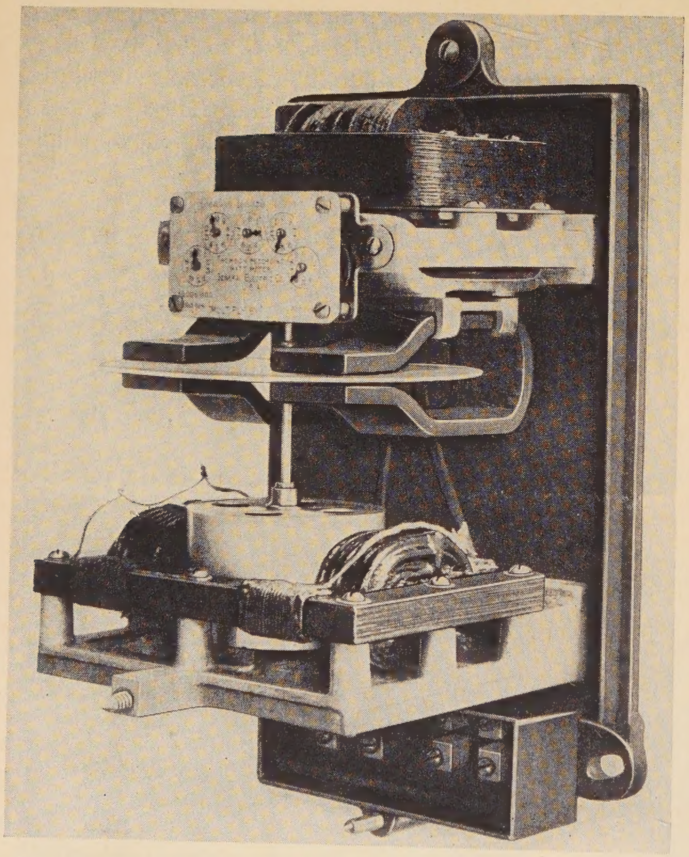
render dishonest and curious tampering with the internal mechanism as nearly impossible as may be.

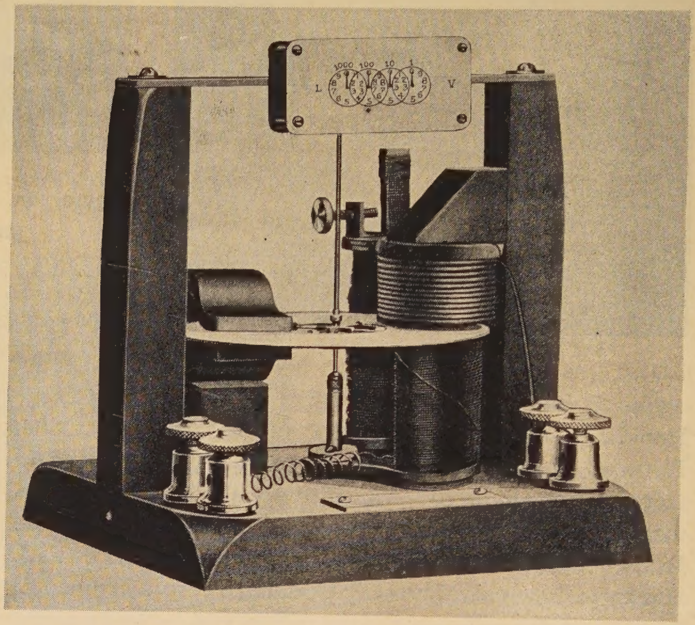
"Third, means for fully protecting from malicious tampering the heads of all screws in the base which bind the damping magnets, etc., in place without rendering them inaccessible to those authorized to reach them.

"Fourth, means for protecting the damping magnets from the occasional depolarizing effect of severe short circuits.

"Fifth, means for immediate and close adjustment of light-load accuracy to meet local conditions without affecting the general calibration."







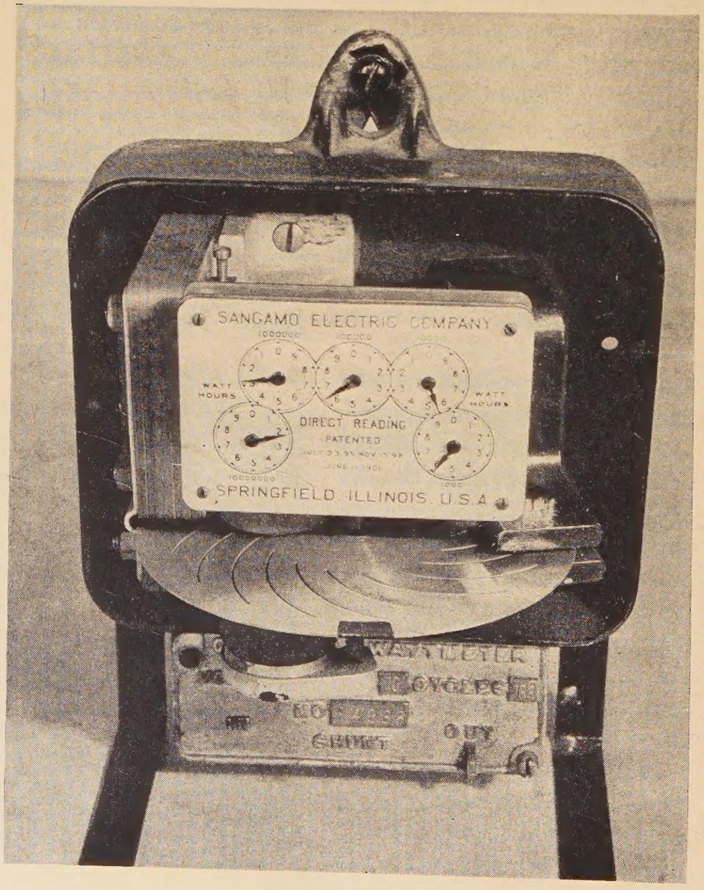
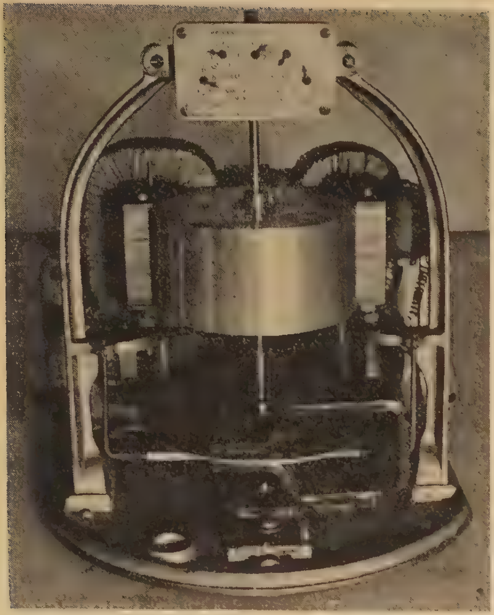
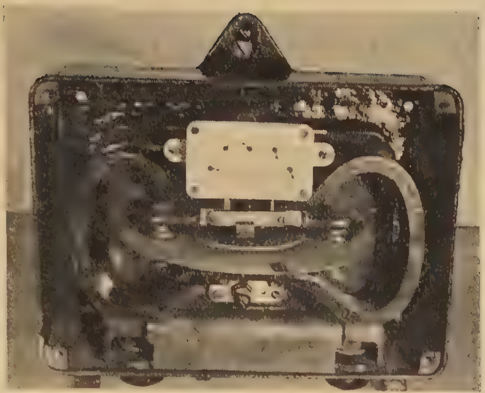


Figure 6a (top left). Shallenberger watt-hour meter
Figure 6b (above). Thomson a-c watt-hour meter
Figure 6c (top right). Duncan watt-hour meter, experimental model
Figure 6d (right). Gutmann a-c watt-hour meter





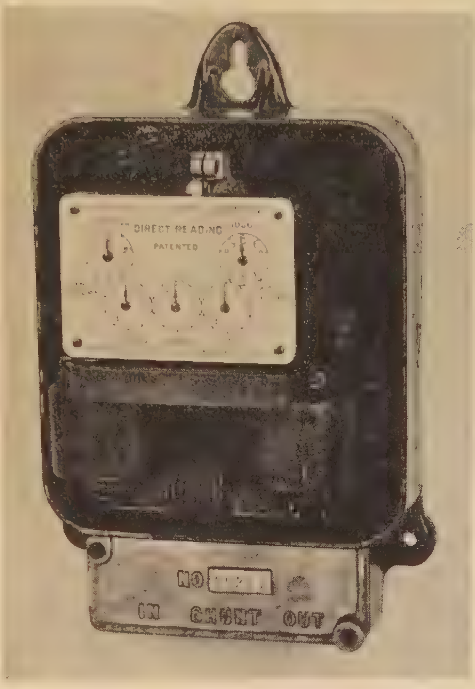


Figure 7a (above). Scheeffer a-c watt-hour meter

Figure 7b (top right). Stanley's magnetic flotation meter

Figure 7c (right). Early mercury motor meter by Lanphier

In these historical statements may be found, to the credit of the manufacturers, a spirit of co-operation which has been fostered over the intervening years until today it ranks as one of the best in industry.

In the minutes of a meter-committee meeting of today, such phrases as "accessibility," "tamper proof," "greater accuracy," "longer inspection periods," are still in frequent use, but it would be wrong to assume that no progress has been made. The correct deduction is, rather, that American meter practice never has been and never will be satisfied. This concept is essential to understand and to appreciate the vast progress that has been made in the art of metering electric energy since 1900.

How and when further improvements were carried out will be covered in the subsequent sections of this report.

It is fitting to conclude this section with a final word about the pioneers. Shallenberger, who died in 1898, did not live to see the true significance of his great discovery. Thomson lived until 1937 and saw the results of his outstanding accomplishments. The remaining pioneers died in the following order: Duncan in 1929, Edison in 1931, and Lanphier in 1939. Because of Schallenberger's ill health, most of his work had been taken over prior to his death by Doctor Frank Conrad of the Westinghouse Electric and Manufacturing Company. All the pioneers, therefore, lived to see the art they helped to create in capable hands, and most of them were active throughout the period of its growth. Of the other men whose names have been mentioned, only Pratt, Vaughen, and Conrad are alive today.

Westinghouse Builds Fluorescent-Lamp Plant

INDICATIVE of the rapid growth of the fluorescent-lamp industry is the $3,000,000 "black-out" plant completed in August at Fairmont, W. Va., by the Westinghouse Electric and Manufacturing Company. Built in less than five months, the first units of this plant comprise a single-story main factory building 224 feet wide and 885 feet long, auxiliary buildings, bus terminal, parking lot, and water reservoir, all fenced and floodlighted for protection. Initial production is scheduled to be 50,000 fluorescent lamps daily; ultimate 200,000.

The windowless factory building is zone air-conditioned throughout and fluorescent-lighted to an intensity of some 40 foot-candles. Some 5,100 40-watt lamps, of a "soft white" color to preserve natural color values, are mounted in open-end luminaires hung end-to-end to form continuous troughs about 12 feet apart and at heights ranging from 10 to 13 feet as required. As dust-free air is especially important in the manufacture of fluorescent lamps, the "black-out" construction was a matter primarily of manufacturing rather than war-time expediency, although provisions have been made to prevent light leakage at doorways and the roof has been treated to prevent tell-tale reflections on moonlight nights. An electrostatic precipitator supplements the regular air-conditioning equipment to remove 90 percent of all air-borne dust or smoke particles, and some 600 "Sterilamps" irradiate the cleaned air in the ducts to destroy bacteria and other micro-organisms. Because some 40,000,000 cubic feet of natural gas per month will be burned in glass working, air will not be recirculated in manufacturing areas. Gas-fired unit heaters will provide winter heating as required. Cooling water (initial capacity 3,600 gallons per minute at 55 degrees Fahrenheit) is drawn from a near-by abandoned coal mine.

To provide required reliability of service and to facilitate subsequent plant expansion, a three-phase, four-wire, 208/120-volt secondary network system of electric power distribution was used. Reliability of the network is enhanced by feeding it from two different 66-kv transmission lines through duplicate 3,000-kva self-protecting transformers of the unit-substation type, and duplicate 6.6-kv feeders to duplicate sets of three 500-kva 3-phase air-cooled network transformers.

Scheduled for completion by May 1942 on the same 95-acre property is a $1,800,000 glass factory intended to supply the glass tubing required by the lamp factory. The manufacture of small incandescent lamps, such as automobile and Christmas-tree lamps, is scheduled to be transferred to Fairmont upon completion of the glass plant.

Fires of Electrical Origin in Factories

G. S. LAWLER
MEMBER AIEE

Maintenance of electrical equipment in a manner appropriate to its importance is urged as a means of combating an increasing proportion of industrial fires of electrical origin

NO ONE will question the statement that electricity in its various uses is a potential source of fire hazard. It usually is kept well under control, but too frequently it "kicks over the traces" and so-called breakdowns occur, many times attended by excessive local heating which ignites insulation, and fire spreads to near-by combustible materials. After a fire starts, conditions determine its extent. Usually it is quickly put out, but sometimes it causes serious loss. It has been said that the lack of a horseshoe nail caused Napoleon to lose the Battle of Waterloo. A case is known where the breaking of some small washers needed to limit the travel of the movable contacts of an oil switch finally resulted in a fire which so damaged an exceptionally large manufacturing plant that 80 per cent of its power requirement was interrupted for about 1$^1/_2$ days.

Electricity is by far the principal cause of fire in the properties insured by the Associated Factory Mutual Fire Insurance Companies. For the year 1940, of all fires reported to them for which claim was made, 21.9 per cent were of electrical origin, and this figure does not include the losses to electrical equipment when lightning was the initial cause. About 5 per cent can be added if lightning losses are included. The amount of all electrical losses in 1940 was 13.9 per cent of the total loss occasioned by fires of all causes. No exceptionally large single electrical loss occurred last year, so the percentage happens to be fairly low. In 1939 it was 65 per cent of the total.

The 1940 fire statistics for the whole United States are not yet available, but for 1939 it was estimated that about 9 per cent of the total number of fires reported were of electrical origin. The electrical cause rated third in importance, smoking being the first and sparks on roofs the second.

The Factory Mutual experience as regards the proportion of electrical losses is higher than that of the United States as a whole, because the Mutuals insure manufacturing plants almost entirely. The average plant value is high and most of them contain extensive electrical equipment. The proportional value of electrical equipment in such plants is much greater than the corresponding figure for the average property throughout the country.

To give some idea of what these proportions are in industrial plants, the percentages applying to a few typical plants for which figures are available are given. A certain large modern newsprint paper mill has 20.6 per cent of its total insurable value in its electrical equipment. If it had its own generating plant the figure would be higher. An up-to-date cotton mill has 4.1 per cent of its value in electrical equipment; a hosiery mill 3.7 per cent; a lace-curtain mill 4.1 per cent; an average machine shop 2.8 per cent; a rubber-product plant 7.6 per cent; a laundry 6.4 per cent; and a large plant making electrical apparatus 12.0 per cent.

In industrial plants and utility properties may be found nearly every type of electrical apparatus made, from the smallest to the largest. The voltages range from the lowest to the highest. The equipment is operated and maintained under varying conditions, some by experts and some by those having less knowledge of the equipment they are handling than it deserves. As practically all electrical equipment is inherently a fire hazard it is not at all surprising that many breakdowns occur.

Some fires of electrical origin, therefore, are to be expected under the best conditions. What a reasonable proportion is remains a matter of conjecture, but it should be less than the 21.9 per cent mentioned, provided the electrical equipment is of suitable type, well designed and constructed, properly installed, and given the attention its importance warrants.

As a simple gauge for estimating whether electrical fires are being kept under control from year to year, it has been assumed that the rate at which electrical equipment has been installed and kept under normal load conditions varies roughly with the yearly output of the utility generating plants in the country. Such a study has led to the belief that before the depression we were holding our own, but since then we have been losing somewhat.

Essential substance of a paper presented at a meeting of the AIEE Lynn (Mass.) section March 11, 1941.

G. S. LAWLER is chief electrical engineer, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

Under the present and future forced manufacturing conditions caused by the war, we are likely to have a greater proportion of electrical fires than we should unless something is done to check them.

It should not be overlooked, however, that although the number of electrical fires is large and increasing, the use of electricity has resulted in a decrease in the number of fires due to other causes, such as flame-type lamps, shafting, and belting. The increase in number is also offset by the benefits which electricity confers, for many of the present processes used in manufacturing plants would be impossible without this form of energy.

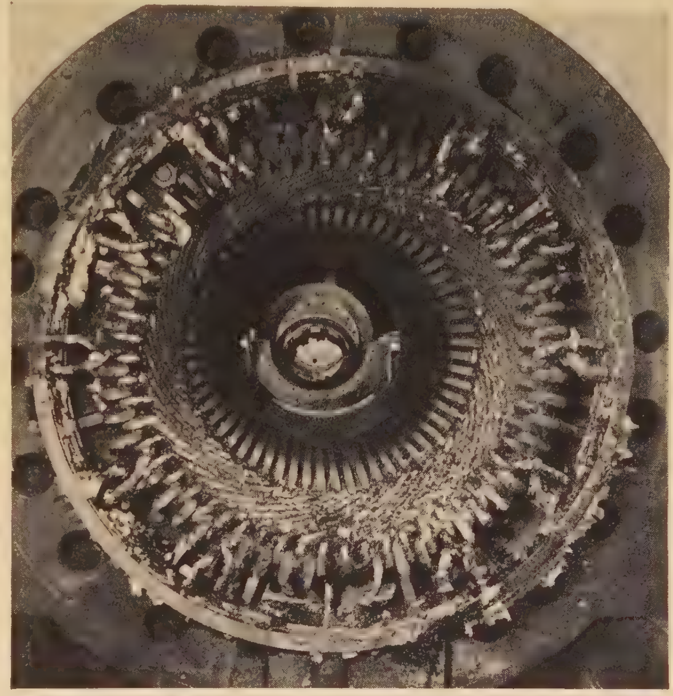
It may be of interest to see where most of these electrical fires begin. The principal offenders are motors. The figures for 1940 indicate that 29.3 per cent of the fires originated in motors of one kind or another. Overheating, resulting from overloads, multiphase motors running single-phase, or stalling, caused a small proportion of the breakdowns, but by far the most were due to failures of winding insulation which resulted in arcing of sufficient intensity to ignite the insulation. In a large proportion of these accidents the fires were confined to the motors, but in many instances the fires spread to combustibles near by. Where the fires have spread, the damage to the motors usually has been only a small part of the total loss, but this is equally true of other spreading fires regardless of the type of apparatus in which the trouble originated. In only a small proportion of the accidents were defects in materials or faulty design the cause of the trouble. Age, bad operating conditions, or lack of proper care of equipment mostly were to blame.

By far the largest number of motors giving trouble were of the squirrel-cage type, but this could be expected because this type of motor predominates in industrial plants by a large margin.

Defective wiring was responsible for 25.5 per cent of the electrical fires. This class is a very broad one and includes transmission, distribution, and branch-circuit conductors, their enclosures, connections, and supports—that is, about everything except the utilization apparatus and its control, protective, and other devices. There are innumerable splices and connections, any of which may become loose. The fact that wiring is in conduit or other type of raceway does not make it immune from possibility of breakdown. A common danger point is where conductors bear on bushings at the ends of conduit lines in cabinets or junction boxes. Vibration or the weight of the conductors in time may damage the insulation so that grounds or short circuits take place. Failure of insulation is frequently accelerated by overloads which some conductors carry. Excessive temperatures cause the insulation to become dry and brittle, and therefore likely to crack or break, especially if disturbed.

The average amount of loss per fire due to breakdowns originating in wiring is greater than for most classes of electrical fires, as more of the fires spread from their point of origin and involve building contents. Also sprinklers are more likely to operate, with consequent damage by water.

Switches and controllers of various kinds were responsible for 17.7 per cent of the fires. There are a great many types of these devices, all of which have moving parts and screw or clamp connections. Moving parts are always subject to wear. Wear is likely to result in loose parts and poor contacts. Screw or clamp connections are likely to become loose, due to vibration, unless checked and tightened occasionally. Manufacturers of controllers have produced very compact devices which are placed in boxes of small dimensions. A short circuit occurring in these small boxes is likely to develop quickly into a more serious one. In addition, the expansion of the air and the gases frequently blow the covers open, allowing molten material to drop or be thrown onto near-by combustibles before the protective devices farther back on the lines can operate.



Differential relays failed to prevent destruction of rotor and stator windings of this 25,000-kva generator. A short-circuit ignited exposed insulation

Oil-immersed autotransformer-type starters have occasioned more fires than other types of starters. This is because the coils have a short-time rating, and because of the presence of oil. Frequently the coils are left in the circuit too long. In a short time they burn out, a short circuit follows, and ignited oil is violently expelled.

The remaining 27.5 per cent of the fires of electrical origin started in many different types of apparatus, such as generators, transformers, circuit breakers, fuses, lamps, resistors, and reactors; also miscellaneous pieces of special equipment used for various purposes. Their troubles are due to a variety of causes, each kind of equipment having its own special weaknesses.

While the proportion of generator fires is small, this is because of the small number in use compared with other kinds of apparatus. The individual loss, however, is likely to be large, as generators are usually of large size and considerable value. A fire in a turbogenerator is almost always serious as far as the generator itself is concerned, unless special means of extinguishing it are provided.

Fire underwriters always emphasize the need of protecting against the hazard occasioned by oil-type transformers. While these transformers are as free from troubles as any type of equipment, they do fail occasionally. Owing to the large amount of oil in them, a fire, if it occurs, is likely to be a large one; and unless the transformers are so located and protected that the fire will be limited to them, great damage to other property may result. Generally, transformers are guarded unusually well as far as other property is concerned, but even so the damage by fire alone in 12 such fires in 1940 averaged over $1,600 per fire. This does not include the damage done by the electric current. If some care had not been taken to separate the transformers from other property the loss would have been much greater. Fortunately, in most cases, there is little or no difficulty in placing them where fire will be limited. Transformers containing nonflammable liquid now available can be located almost anywhere, as far as their fire hazard is concerned. The number of these in use is increasing, partly because expensive precautions are unnecessary, and partly because in spite of their greater cost the over-all cost of an installation may be less than for transformers of the oil-immersed type.

There are four factors that chiefly influence the fire hazard of electrical installations:

1. Their design and construction.
2. How they are installed.
3. How they are operated.
4. The quality of maintenance they receive.

If all these factors were given careful attention there would be a much smaller number of electrical fires and such fires as did occur would be considered reasonable. In some plants all four of these factors have received generous attention and consequently the fire record has been excellent. In many other plants, however, one or more or even all of the factors have been more or less neglected and their electrical-fire records have suffered accordingly.

The first and second factors, namely, construction and installation, are the ones to which inspection bureaus and departments have given most attention.

The first is handled by requiring that, as far as obtainable, apparatus, devices, and materials used be approved by a recognized testing laboratory and included in the laboratory's published list of approved devices. All types of equipment cannot be put through the laboratories, but those in general use are. Motors, generators, power and most lighting transformers, and similar heavy apparatus are not passed upon.

The laboratories examine and test apparatus submitted to them, and if the design and construction is deemed satisfactory according to their standards, and the equipment meets certain test requirements, it is approved and listed. Such a list can be obtained by anyone desiring a copy.

Installation is taken care of by requiring compliance with the rules of the National Electrical Code.

If an installation comprises apparatus, devices, fittings, and materials well selected for the purpose, approved by the authorized laboratories, and installed in accordance with the National Electrical Code it starts its career in the best possible shape. If it more or less departs from what is considered an excellent installation in these regards, then the chances of later trouble followed by fire increase, the increase depending upon the degree of departure. Some departures are intentional and result from a desire to cut first costs, while others are due to lack of proper knowledge.

After an installation is in, the third and fourth factors, namely, operation and maintenance, become very important. If the equipment is operated as it should be and is not abused by overloading or mishandling, and if it receives the degree of maintenance it should, considering the conditions to which it is subjected, little or no trouble will be experienced. If, however, even the best equipment is abused and neglected, breakdown with its attendant probability of fire is almost sure to occur.

The inspection bureaus and departments in general give very little attention to electrical equipments after they have been approved at time of installation, unless some accident directly calls their attention to undesirable conditions.

Experience clearly indicates that the degree of maintenance which electrical equipment receives is fully as important as, if not more important than, the care with which it is installed, as an influence on the accident and fire record. A poor installation given good care by an able conscientious electrician usually will give less trouble than an installation that originally was excellent but cared for by an incapable, careless electrician. The fact that an equipment is old and antiquated does not always mean that it is poor from a fire standpoint. It still may be as good as when installed. A manufacturer cannot be expected to change his equipment to comply with each successive edition of the National Electrical Code as it is produced, but he can keep it in good condition.

Accurate figures of the proportional number of fires which can be attributed to lack of proper care and maintenance are difficult to obtain, but the proportion may be as high as 50 per cent. Factory Mutual figures for 1940 indicate 42 per cent, but this is probably low. The proportion has been increasing ever since the recent depression started. Business became so poor that many plant managements cut maintenance to the bone, and even into it. Many undoubtedly thought that when business conditions improved they would get their equipment into shape again before it had received permanent injury. Some evidently thought, if they gave it *any* thought, that electrical equipment would stand up almost indefinitely without care. The result has been that many equipments have been neglected for so long that permanent injury has resulted. When they have been called upon to resume their normal, or near normal, loads, breakdowns followed by fires have occurred.

The present great increase in activity in production due to the war has, and will have, an accumulating effect on the number of breakdowns and fires. The degree of maintenance equipment receives will be a very important factor in this regard.

At plants operating additional shifts or almost continuously, the length of time important equipment can be shut down for repairs and attention is too short to accomplish desired results unless additional men are assigned to the work. It is difficult to get experienced men at present. The result is sure to be more breakdowns and fires with their attendant effect upon urgent production. An increase in the number of fires has already been noticed.

Any experienced man in charge of electrical equipment knows what constitutes reasonably proper maintenance. The equipment should be visited and checked at intervals suitable for the conditions under which it operates. Moving parts should be checked for wear, and adjustment and minor repairs made at the time any weakness is found. Major repairs should be made just as soon as possible. Switches, controllers, and circuit-breaker contacts should be smoothed if rough, and replaced if necessary. Oil should be kept at the proper level in oil-immersed apparatus and in the bearings of rotating machinery. Oil in transformers should be tested at suitable intervals and filtered or replaced as needed. Doors of cabinets containing electrical apparatus should be kept closed. Dirt and lint should not be allowed to accumulate in cabinets and boxes. Special care should be given to motors. Air gaps should be kept uniform. They should be blown out at intervals depending on the nature and extent to which combustible fly or dirt accumulates on them. Special care should be taken that oil does not get onto the insulation. Overload protective devices should be of proper rating or setting and kept in operative condition. These items are only a few of those that need attention. What should be done, how it should be done, and how frequently, will vary from plant to plant.

In my experience deficient maintenance becomes more quickly evident with motors than with any other class of apparatus. To get a quick general idea of the quality of maintenance in any plant it is only necessary to observe first whether there is any quantity of dirt, and especially of oily dirt, on the motor windings. If there is an accumulation, it is almost a certainty that the rest of the equipment is not being maintained as it should be. Deposits of dry dust or dirt, however, are unavoidable in some plants, such as cement plants, and usually will do little harm unless ventilating ducts are obstructed. If oil is mixed with the dust or dirt a rapid deterioration of the insulation is bound to occur. The presence of oil usually is due to too much being put in the motor bearings. The excess oil escapes around the shafts from the bearings and some finds its way onto the windings. The use of too much oil is frequently occasioned by an endeavor to cut down the number of visits to motors and thus save time and expense. It is believed that a few extra squirts from the oil can will accomplish the desired purpose. Oily dirt on the windings is a principal, if not *the* principal, cause for the position of motors at the head of the list of types of equipment prominent as a place of origin for fires.

Factory Mutual inspectors, during their frequent periodical visits to plants, are instructed to pay particular attention to the way electrical equipment is maintained and to recommend improvements where maintenance is not up to a reasonable standard. This will be emphasized even more in the future than in the past, for it is the most promising way of reducing the electrical loss.

So far only the direct loss due to fire has been mentioned, since fire-insurance companies cover only that type of loss, but many other kinds of loss attend most fires. Some of the other losses are tangible and some intangible. First there is the part of the direct damage caused by the electric current itself. This may or may not happen to be covered by insurance. As it is not covered by the fire-insurance companies, none of the figures given include it. The aggregate of such losses, however, is considerable and in some instances it may be the principal loss. Fires affect production to a greater or less extent, depending on the extent of the fire, the size and type of equipment involved, and the purpose for which the equipment is used. If the effect on production is serious, employees may suffer a loss of wages. Sometimes orders are cancelled if the product cannot be delivered on time. The management and assistants occasionally have to put in extra work in getting things going again and this may be accompanied by considerable anxiety, for other necessary duties have to be postponed until conditions are brought back to normal.

There is no profit to a manufacturer in having a fire. Profits are made by avoiding them. One of the best ways of preventing direct loss and of assuring uninterrupted production, and thereby profits, is to take reasonable measures to have the electrical equipment well adapted to its purpose, well installed, properly operated, and especially to have it receive the care its importance deserves.

A "live" wire, dropping out of a lug on the wall, burned a hole in the grounded tank of a transformer and caused an oil fire in this vault

Radiography at High Speed

LOUIS F. EHRKE
ASSOCIATE AIEE

CHARLES M. SLACK
NONMEMBER AIEE

Development of a cold-cathode X-ray tube makes it possible to make records on film of distortion inside objects opaque to visible light, thus supplementing high-speed photography

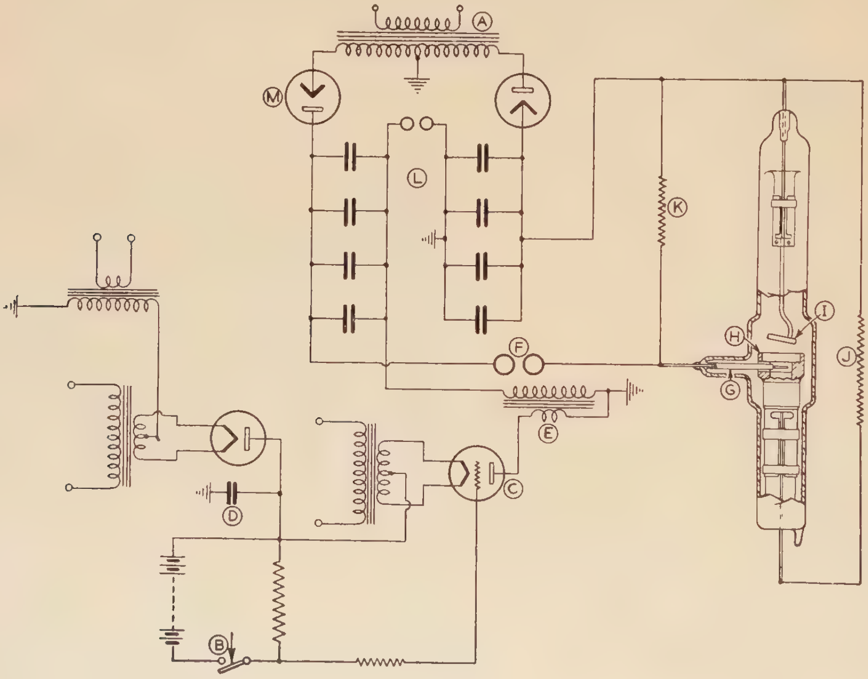
THE interesting results attained by ultrahigh speed or flash photography are well known to newspaper and magazine readers everywhere. Distortion due to momentary strain can be shown in many familiar objects, such as golf balls and rapidly vibrating open relays. A new technique using X radiation instead of visible light makes it possible to record distortion or change in the interior of opaque objects as well as that visible on the outside.

To make such radiographs at speeds of about one microsecond, enormous currents must be passed through the X-ray tube for that very short time interval. In the conventional hot-cathode X-ray tube, the available electron current is definitely limited by safe cathode temperature and space-charge effects. These limitations are avoided by the use of a cold-cathode X-ray tube recently developed in the Westinghouse lamp research laboratories at Bloomfield, N. J.

In place of the conventional filamentary cathode, this tube employs a pair of cold electrodes *G* and *H* (figure 1). *G* is the true cathode and is so shaped and located with respect to its auxiliary electrode *H* that enormous potential gradients are built up when voltage is applied between these electrodes. Under the influence of these high gradients, a copious supply of electrons is obtained by cold emission from electrode *G*. Currents of from 1,000 to 2,000 amperes pass through the tube for periods of about one microsecond. The X-ray energy produced under these conditions is sufficient to produce radiographs of many objects in this short time interval, and consequently rapidly moving objects may be radiographed without blur caused by motion.

LOUIS F. EHRKE and CHARLES M. SLACK are research engineers with the Westinghouse Lamp Division, Bloomfield, N. J.

Figure 1. Circuit diagram of the new ultrahigh-speed X-ray tube and auxiliary equipment



Operation

A—High-voltage transformer for charging capacitors *L* through rectifiers *M*. When timing circuit is broken at *B*, a negative charge on the grid of thyratron *C* is dissipated, allowing capacitor *D* to discharge through the primary induction coil *E*. This voltage is carried through main capacitors, causing spark gap *F* to break down, activating the X-ray tube. This places the total voltage between the negative or cathode electrodes *G* and *H*. Cold or field emission working across this narrow space causes electrons to be pulled from the cold metal of *G* to *H*. As soon as this current starts to flow, the voltage between *G* and *H* diminishes, and the electron stream from the cathode "hot spot" on *G* is diverted to the anode *I*, directed or focused by *H*. X rays are generated at *I* by the impact of this electron stream. The diminution of voltage is caused by blocking action of high resistance *J*. Resistance *K* is placed directly across the capacitors and gap to insure that the breakdown at gap *F* will be consistent with its spacing

Constants

A	125 peak kv, 5 milliamperes, center grounded
Valves	125 peak kv inverse—10 milliamperes
Capacitors (*L*)	60 kv direct current 0.04 microfarad (two only needed for most applications)
D	4 microfarads, 1,000 volts,
E	Equivalent of an automobile coil giving a negative high-voltage impulse approximately 20 kv
K and *J*	Approximately 100,000 ohms

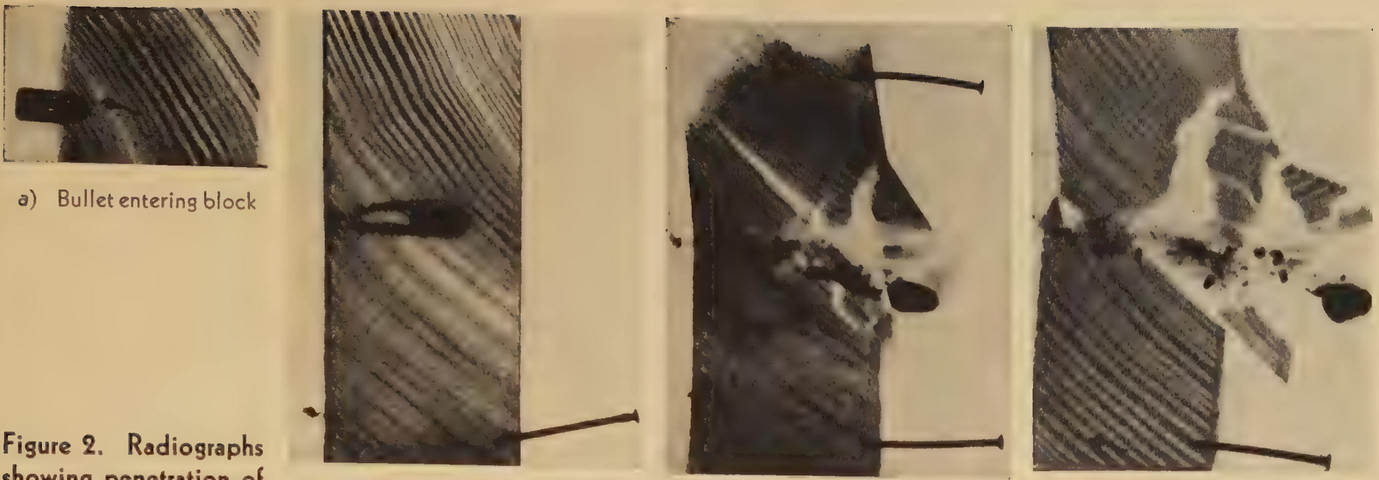


Figure 2. Radiographs showing penetration of a projectile into a wooden block

a) Bullet entering block

(*b*) Bullet has entered block; note rapid closing of hole by wood fibers

(*c*) Bullet emerging from block

(*d*) Bullet has left block. Note lead particles broken from bullet in its passage

A basic circuit is shown in figure 1. The high-voltage transformer *A* feeds capacitors *L* through rectifiers *M*. Capacitors are charged to a potential slightly less than that required to break down the gap *F*. When it is desired to fire the tube by passing the capacitive charge through it, the firing circuit is opened at *B*. This permits the negative charge on the grid of the thyratron *C* to leak off and the charge on capacitor *D* then passes through the thyratron and through the primary of induction coil *E* to ground.

This sudden passage of current produces a high voltage in the secondary of *E*, which raises the potential of capacitor bank *L* so that the total voltage across the capacitor is now great enough to break down gap *F*. When this occurs, a discharge starts between *G* and *H*, the discharge immediately transfers to anode *I* which is of conventional design, and X rays are produced.

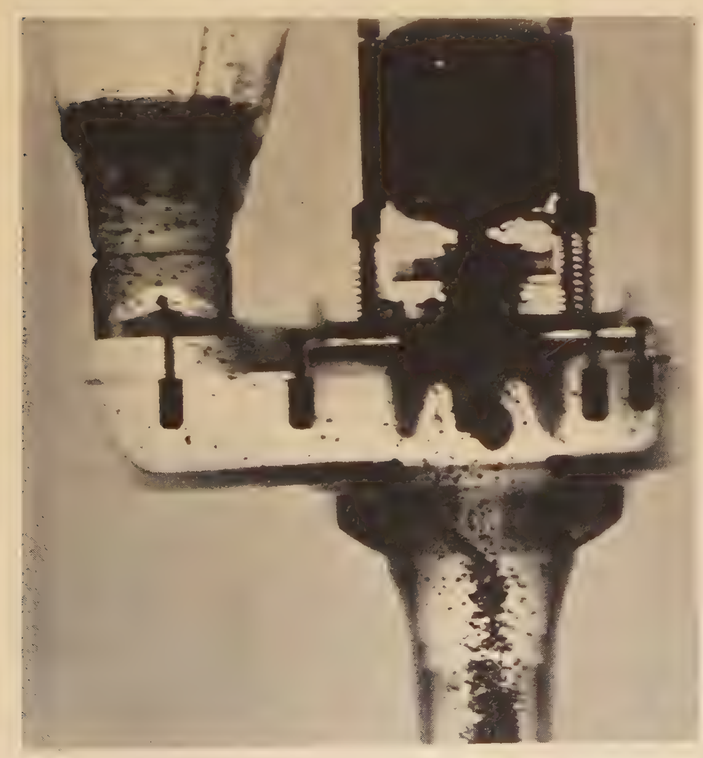


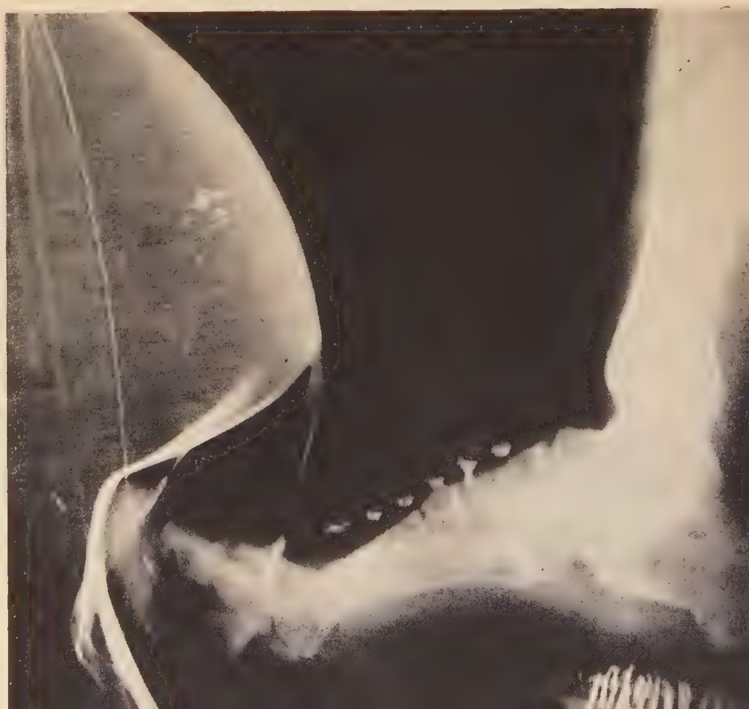
Figure 3. Here the high-speed X-ray tube has radiographed the interior of a vacuum cleaner in a millionth of a second. Flow and relative air velocity can be judged by the distribution of the particles

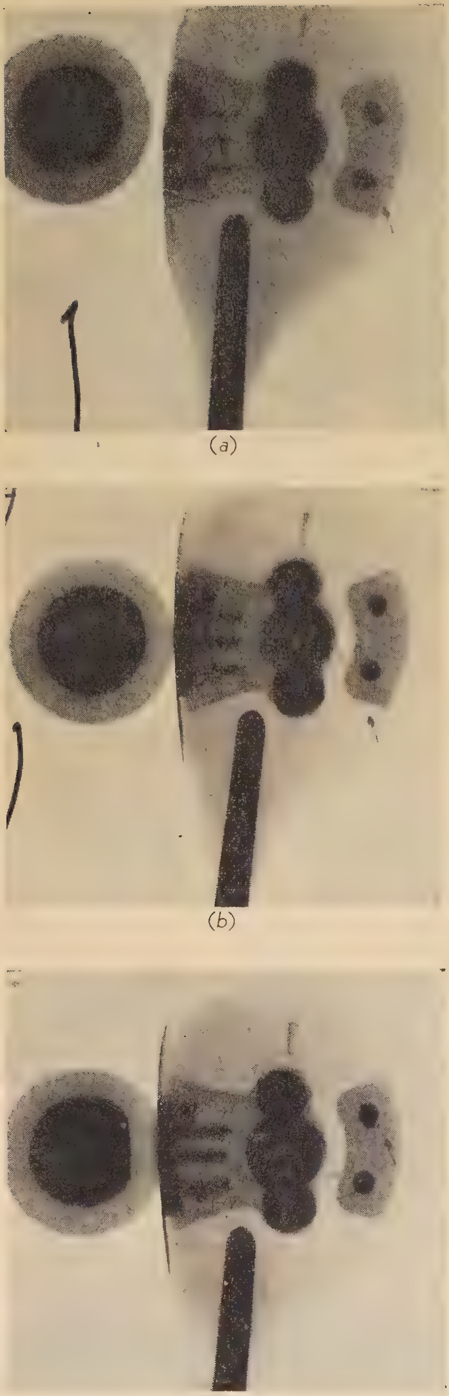
Current measurements, made by noting the voltage drop across a straight resistance wire in series with the anode of the tube, indicate that peak currents of from 1,000 to 2,000 amperes are common. Several wires of different lengths and diameters but of the same resistance are used to avoid errors caused by the self-inductance of the wire. Time of discharge and capacitance are also a measure of the current.

The time during which this large current passes and during which X rays are produced is of course extremely short—about one microsecond. The method used to measure this time interval is as follows:

A 0.220 Swift bullet was radiographed in free flight. The velocity of this projectile is about 4,100 feet per

Figure 4. A radiograph showing a foot striking a football





(a)

(b)

(c)

Figure 5. Radiographs showing club striking golf ball

(a) Club head approaching ball

(b) Club head makes contact with ball

(c) Core of ball partly compressed

(d) Maximum compression of core

(e) Core starts to re-expand

(f) Ball leaving club

second. Therefore, the projectile moves 1.25 millimeters in one microsecond. The amount of blurring in the radiograph of the bullet is measured and indicates the duration of the X-ray exposure. Blurring of about one millimeter with this type of projectile is common and the exposures are, therefore, about one microsecond. Calculations from the charge on the capacitor system and peak current also indicate exposure times of this order.

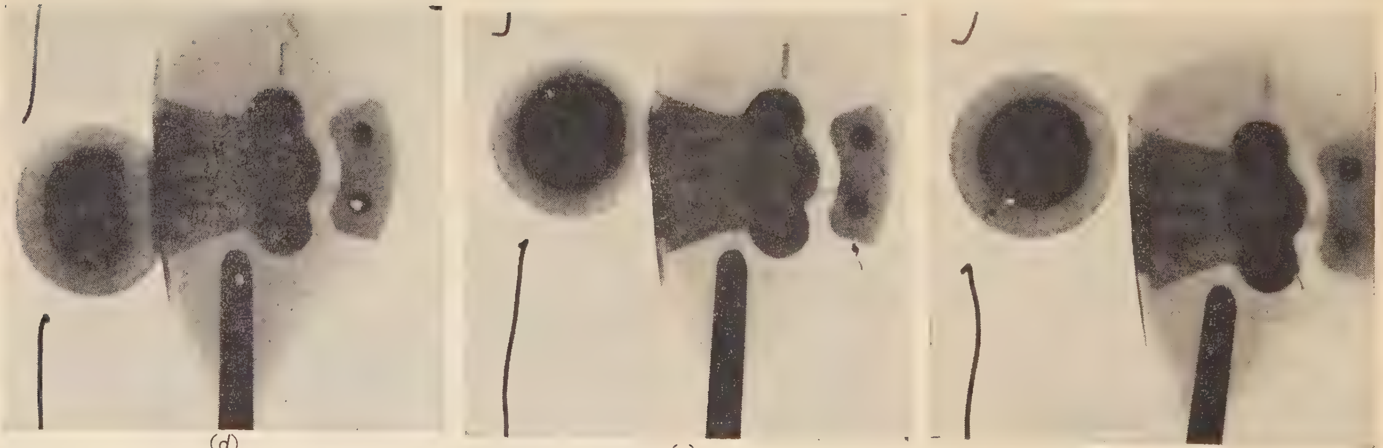
The field for ultrahigh-speed radiography of this type as yet has not been widely explored. The ability to record the interior change in shape of rapidly moving enclosed parts under stress, or a momentary condition in a short-time phenomena such as the striking of a golf ball or the penetration of a projectile into a wooden block, would seem to place a new tool at the service of those investigating such phenomena.

The usual method of firing the tube is to bridge switch *B* with a fine wire which is broken by the projectile, in the case of the bullet pictures. Variations of this method include a double swinging contact device of high sensitivity which was used for the golf pictures. The time interval which elapses between breaking this contact and the firing of the X-ray tube may be controlled by suitable choice of the grid-leak resistor in the thyratron circuit. The desired phase of the action also may be selected by the location of the wire with respect to the object to be radiographed. These methods are adaptable to a wide variety of conditions, and are cited merely to show the general principles involved.

Series sets of various phases in the golf ball cycle and the bullet going through wood are made up of separate X-ray shots of separate specimens, the exposures being so spaced through the cycle that a series of consecutive discrete phases is recorded. A similar series showing the passage of a charge of shot down the barrel of a shot gun has also been made.

The voltage used to produce the pictures shown here was in the region of about 120-kv peak. The wave length of the X radiation produced at this voltage is about 0.1–0.2 angstrom units, or about 10^{-9} centimeter, whereas visible light—for example, the yellow sodium line—has a wave length of about 5,800 angstrom units.

This short wave length of the X rays is responsible for their ability to penetrate objects opaque to visible light.



(d) (e) (f)

It also is responsible for the fact that one cannot refract or focus the X rays as one does visible light with a camera lens. For this reason, no lens is used, and the X-ray pictures are a type of shadowgraph made by placing the object between the X-ray tube and the film which is enclosed in a light-tight box known as a cassette. Under the influence of X rays, the object then casts a shadow of varying density on the film, and the picture is made.

The closer the object can be placed to the film, the better the definition obtained, other conditions remaining unchanged. For this reason, the bullet pictures made by firing close to the film show better definition than does such a picture as that of the football and foot, which were necessarily farther from the film. Efficiency of the photographic effect is increased, as in other radiographic practice, by the use of fluorescent intensifying screens, which are placed in contact with the film surface and enhance the direct effect of the X rays on the emulsion by fluorescent light.

Successful industrial applications of this system will depend largely on the thickness of the parts to be penetrated by the X rays, the degree of distortion or change to be detected, and the fineness of definition required in the picture. The exposure time of one microsecond appears to be short enough to freeze motion substantially in any application considered so far. The extent of the field to which this development will be applied will become clearer as experimental work proceeds.

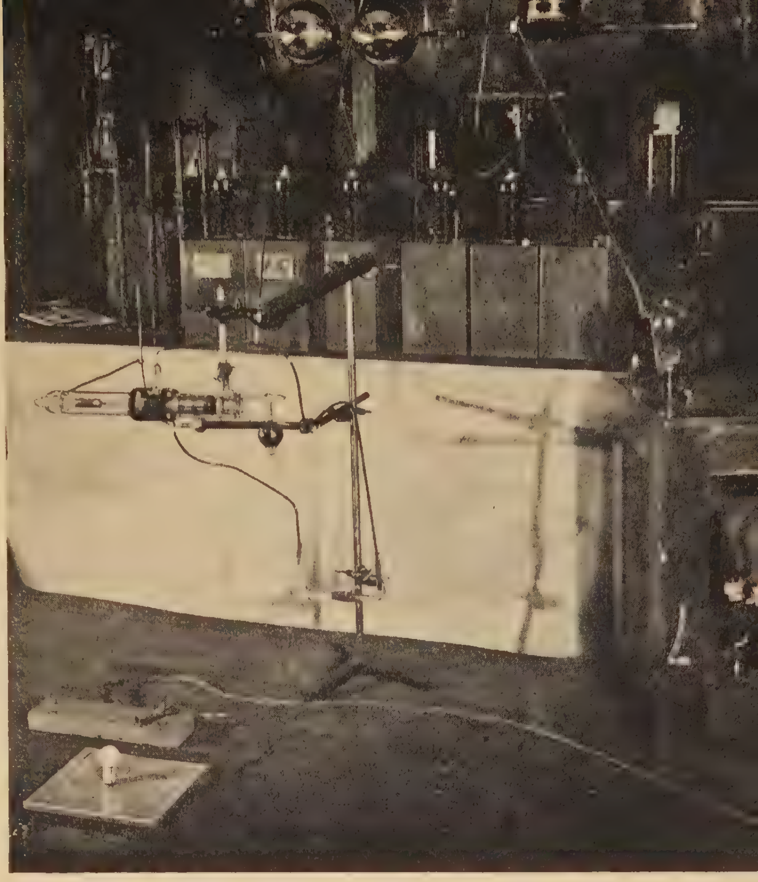


Figure 6. A typical setup as used for taking a golf picture

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Effects of Corona and Spark-Over in Freon

FRANK T. DeWOLF

Gases are being used to an increasing extent as insulating media for high-voltage equipment; this article reports the results of tests of the chemical stability of Freon, which has been found most satisfactory in such applications.

PERHAPS the most effective means of increasing the compactness of high-voltage apparatus is the use of insulating media of higher dielectric strength. With the development of ultrahigh-voltage equipment[1,2] a number of gases have been examined as to their qualifications as dielectrics. Among these is Freon, CCl_2F_2, a gas having a dielectric strength about three times that of air at the same pressure[3,4,5] and a vapor pressure of 85 pounds per square inch absolute at 20 degrees centigrade. It is nonpoisonous, nonflammable, and noncorrosive under normal conditions.

However, the question of the chemical stability of Freon in the presence of corona and spark-over remained to be answered before its general use as a practical high-voltage insulating medium could be justified. When Freon was introduced into the field of refrigeration, tests showed that it breaks down chemically in the presence of a naked flame producing active decomposition products which are both corrosive and poisonous. Slight decomposition of the gas following corona and spark-over had been noted in early tests of its dielectric strength, but this phase had not been investigated thoroughly. This research was undertaken to see to what extent the disintegration of Freon by corona and spark-over limits its use as a dielectric. Further, it

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Frank T. DeWolf was a graduate student in electrical engineering at Massachusetts Institute of Technology, Cambridge, during the course of the research reviewed in this article; he is now with the General Electric Company, Lynn, Mass

The author wishes to express his sincere appreciation for the kind help that Doctor John G. Trump of the department of electrical engineering of Massachusetts Institute of Technology extended to him during the research on which this article is based.

was planned to note the extent by which the corrosive influence of the decomposition products might be reduced by the use of some deactivator, such as lime.

In the tests comprising this research a small volume of gas, two liters in most tests, was subjected to a measured amount of corona and spark-over. Some tests were conducted to measure any change in the dielectric strength of the gas. Most of the tests, however, were concerned with the effects of the decomposition products on a specimen of metal or insulator enclosed within the chamber. Materials other than the specimen were covered with protective coatings so that the influence of the decomposition products could be concentrated on the test piece.

A d-c voltage was applied to both spark gaps and corona gaps during the various tests; however, corona activation was used primarily. A record of both ampere-hours and volt-ampere-hours was kept during the course of the 35 individual tests made. Typical figures during a corona run were: average voltage, 8.5 kv; average current, 25 microamperes; length of run, 70 hours.

A few of the tests were conducted in distilled, dried Freon. A number of others were run in air. However, most of the tests were conducted at atmospheric pressure in a mixture of Freon and undried air in a ratio of six to one, by volume. This was done because in practical applications air is nearly always present with the gas; often intentionally, so that pressures higher than the vapor pressure of Freon may be used.

A gap between two hemispherical electrodes served as the means of measuring the insulating strength of Freon. After about 40 hours of spark-over at 5.5 kv with an average current of 1.0 milliampere the dielectric strength of the gas was found to be unchanged, although it was evident that much decomposition had taken place. These results were later substantiated using corona activation. Corona and spark-over in Freon, although effective in decomposing the gas, do not materially lower its dielectric strength.

EFFECTS OF DECOMPOSITION PRODUCTS

Samples of brass, steel, copper, and aluminum were subjected to corona in air and in Freon, with and without lime present. The samples, tested individually, were inspected visually and with the aid of a spectrophotometer.

The specimens subjected to corona in Freon with lime present showed no visible effects immediately upon removal from the flasks although they darkened slightly after several days exposure to the air. With no lime present, chemical activity was evident in all cases except that of aluminum. When the flasks were opened, immediate secondary reactions took place, the corrosive films changing in appearance.

With distilled, dried Freon, the chemical attack on metals was much less severe than with Freon and air mixtures. Further, it was found that chemical corrosion of metals could be entirely prevented by the use of Lucite and Glyptal as protective films.

Even with no protective measures, however, these metals were not attacked as severely as when subjected to the same intensity and duration of corona in air alone. Thick crusty coatings were formed over the surface of the specimens which differed in color and coarseness from the thin films formed in the case of corona in Freon. The results of corona tests in air served to show the intensity of the discharge to which Freon was subjected. Since electrostatic generators of the Van de Graaff type have functioned in compressed air for long periods of time with but slight corrosion taking place, Freon, even without deactivation measures, should be suitable for such applications.

The decomposition products of Freon seemed to have no effect on rubber or Textolite. Glass was only very slightly etched after the most severe of the spark-over runs. Activated Freon greatly decreased the strength of fabric cord when no lime was present. With lime, however, cord specimens were weakened less than similar specimens subjected to corona in air.

Some surface-leakage tests were performed on disks of Textolite in Freon before and after subjection to corona. Although the surface-leakage resistivity was lowered by corona in Freon by a factor of nearly ten it was still 10^{11} ohms per centimeter. Further tests with Textolite showed that upon exposure to air the insulator resumed its original resistivity value in air. Thus, although activated Freon lowers the surface resistivity of Textolite, the decrease is neither great nor permanent.

Samples of sheet insulation were tested as to puncture strength following their subjection to corona in air and in Freon, with and without lime. The insulating strength of paper was greatly decreased in tests with no lime present; however, with lime, paper specimens were weakened less than were samples subjected to corona in air. Regardless of the presence of lime the puncture strength of varnished cambric was decreased permanently about 35 per cent by corona in Freon. Sheet rubber was apparently unaffected by corona in air or in Freon, with or without lime.

CONCLUSIONS

Although Freon may be decomposed by corona and spark-over its dielectric strength is not reduced materially nor are the decomposition products formed particularly troublesome. In general, metals and insulators are not damaged any more severely by corona in Freon than by subjection to similar activation in air. Further, it was found that adverse effects can be decreased, first, with the use of as high a purity of Freon as possible, second, by the use of some chemical deactivator placed near the corona or spark-over source, and third, by the use of protective films over vulnerable surfaces.

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A Stabilized Neon-Tube Direct-Coupled Amplifier

WILLIAM H. HUGGINS
ENROLLED STUDENT AIEE

IN recent years, the application of vacuum-tube amplifiers in many fields has greatly increased. Amplifiers capable of handling frequencies in the range of from 40 to 15,000 cycles per second are common, and in the many applications where it is necessary to amplify signals of frequencies much less than 40 cycles per second, the low-frequency response has been obtained by rather elaborate compensating devices.

However, even with compensation, there exists a still lower limit of frequency, below which satisfactory amplification with allowable phase distortion cannot be obtained. One solution of the problem has been the employment of some method of direct-coupling between the amplifier stages. In addition to direct coupling, modern design dictates that the amplifier should be capable of operating from a single a-c power supply.

Figure 1 is a diagram of the circuits that have been used in the development of direct-coupled amplifiers particularly suited for use with the cathode-ray oscilloscope. This method of obtaining direct-coupled amplification uses neon tubes as the coupling elements. The necessity for an amplifying circuit which is inherently stable leads to the use of the degenerative cathode resistor. This circuit is particularly applicable where several amplifying stages must be operated from the same power source. The stabilized amplifier and its power supply are shown in figure 2.

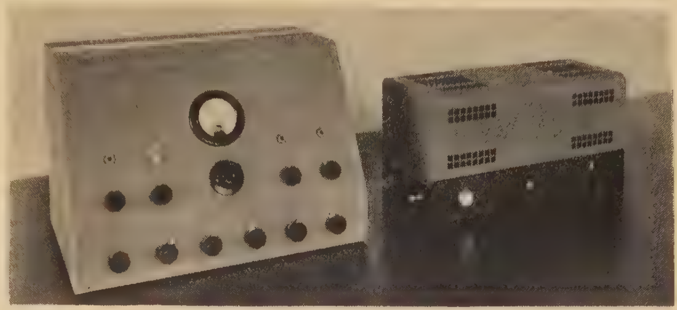

Figure 2. Amplifier and power supply

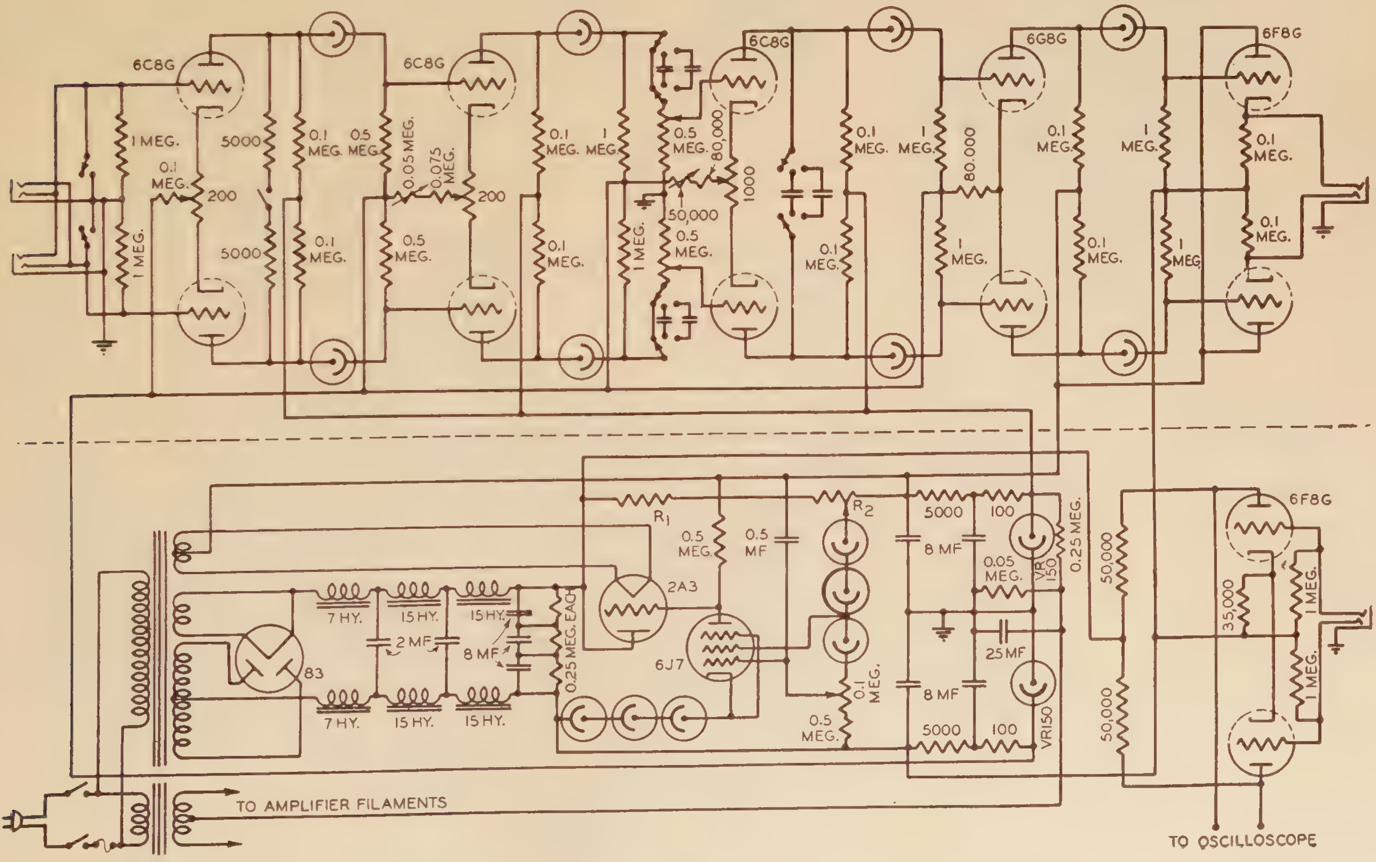

Figure 1. Stabilized gas-tube-coupled amplifier

Abstracted from a paper of the same title presented at a joint meeting of the Portland Section and the Oregon State College Branch, Portland, Ore., May 18, 1940, and subsequently awarded the AIEE national prize for Branch paper for the academic year ending June 30, 1940, which award was presented at the Institute's recent 1941 summer convention.

W. H. Huggins was a student at Oregon State College, Corvallis, when this paper was prepared; he is engaged at present on a study of aircraft-precipitation-static radio interference, being conducted at Oregon State College for the National Defense Research Committee.

Lightning Phenomena

II—Instruments for the Measurement of Lightning Surges

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FELLOW AIEE

G. D. McCANN
ASSOCIATE AIEE

A number of special instruments have been developed to secure the information about lightning which utility system engineers must have if they are to devise adequate protection for the system. Such instruments are described in this second part of a series of three articles on lightning, of which part I appeared in the August issue, and part III is scheduled for next month.

OF primary importance in the lightning protection of transmission lines is a knowledge of the magnitude, duration, and wave shape of the voltage and current surges appearing on utility systems. The characteristics of the stroke itself determine the resulting surges which occur on the electrical systems. Thus it becomes desirable to have instruments capable of measuring not only the system voltages and currents, but also the properties of the stroke.

One difficulty encountered in the development of such instruments is the wide recording range both in magnitude and time that must be covered. Currents vary from a few amperes to 200,000 amperes. Portions of the wave change so rapidly that time intervals of the order of a microsecond need be measured, while at the same time the duration of the complete stroke may be longer than one second or 1,000,000 microseconds.

The element of chance is also introduced in that the point at which lightning may strike is unpredictable. The probability of a given point being struck is enhanced by height so that in some cases instruments are installed on tall objects. However, the available evidence indicates that discharges to such objects differ in important aspects from those to low objects. In order to obtain data that are truly characteristic of strokes to transmission lines and other electrical equipment, the observer is faced with the prospect of placing a large number of instruments in the field with the hope that some will obtain for him the desired information. Economic considerations thus place a very serious limitation upon the instruments, since to be practicable for use in large numbers their unit cost must be small.

Since voltage rather than current is the immediate cause of system outages it is natural that field measurements were first made of voltages produced on lines by lightning. Thus voltage-measuring instruments were developed first.

SPARK GAPS

The first attempts were made with a relatively crude device consisting of parallel gaps with different spacings. To prevent the first gap to break down from short-circuiting the others and to prevent a system outage, a relatively high resistance was placed in series with each gap. The maximum gap broken down, which was indicated by markings on a thin piece of paper, was a measure of the voltage. Peek[27] used sphere gaps and needle gaps in parallel to obtain a measure of the wave shape. A comparison of the length of gap sparked over for the two types of electrodes gave some indication of wave shape.

THE KLYDONOGRAPH

The first successful field instrument developed for surge-voltage measurements was the klydonograph, invented by J. F. Peters[28] in 1924. In 1777, Doctor G. C. Lichtenberg discovered that figures can be produced in sulphur dust

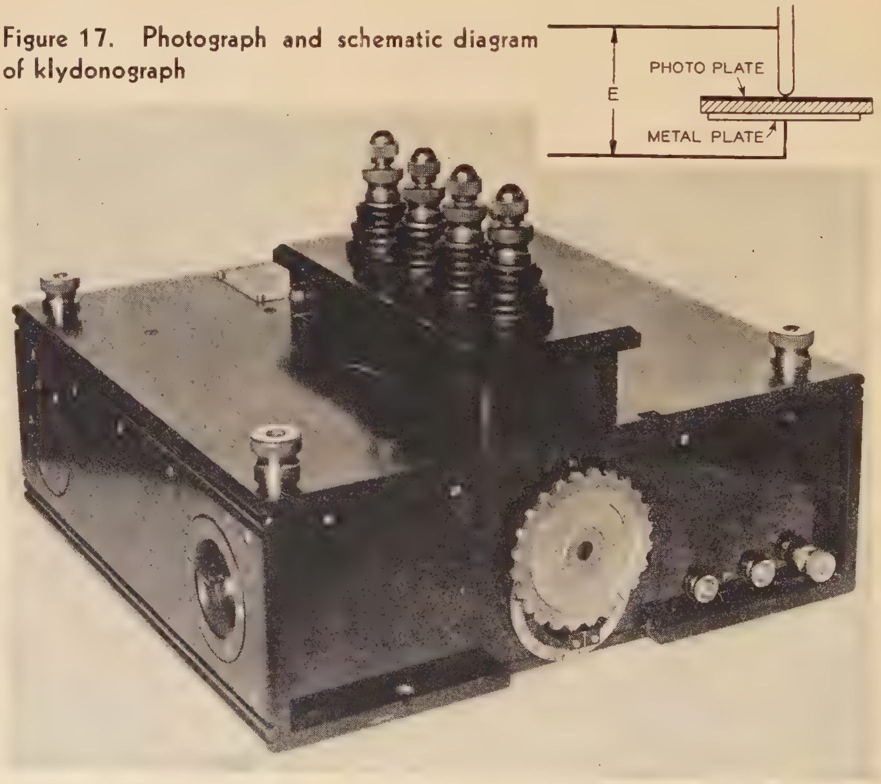

Figure 17. Photograph and schematic diagram of klydonograph

C. F. Wagner is manager of central-station engineering and G. D. McCann is a central-station engineer with Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

27. For all numbered references, see list at end of article.

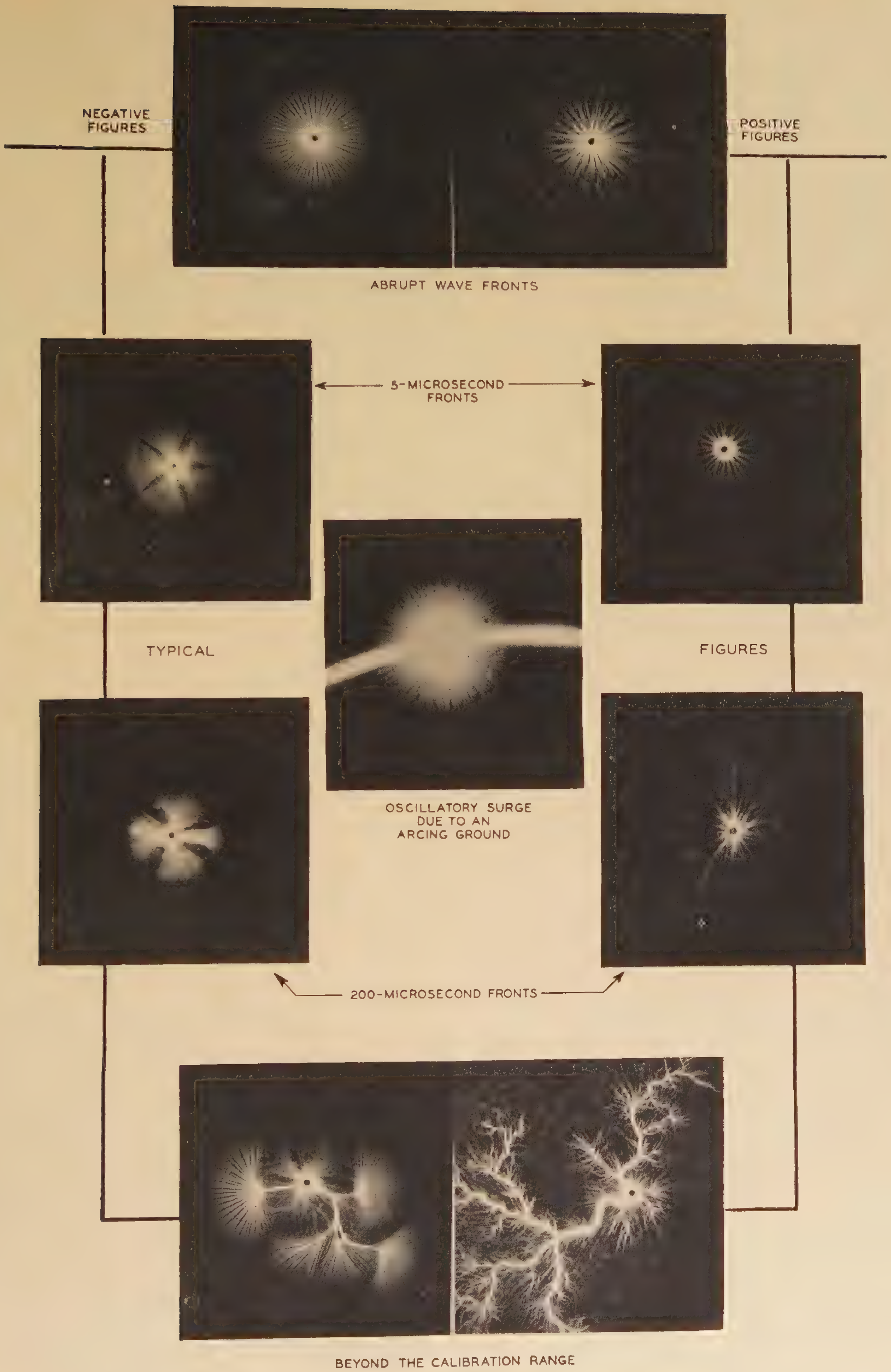

Figure 18. Typical klydonograms

by the electrostatic field of a charged electrode placed near by. Others found that Lichtenberg figures could also be produced on photographic plate. These figures are functions of the magnitude, polarity, and wave shape of the impressed voltage. The klydonograph (figure 17) employs these characteristics for the measurement of surge voltages.

The klydonograph consists of a rounded electrode bearing upon the emulsion side of a photographic film or plate resting on the smooth surface of an insulating plate backed by a plate electrode. In figure 18 are shown typical klydonograms obtained for different types of voltages. The minimum critical voltage necessary to produce a figure is about 2.0 kv and the maximum voltage that can be recorded is about 18 kv, since at higher voltages spark-over occurs and fogs the film.

For unipolarity there are characteristic differences between the figures for positive and negative voltages. However, for either polarity the radius of the figure, if it is symmetrical, or the greatest distance from the center of the figure to its outside edge, if it is unsymmetrical, is a function only of the applied voltage. Oscillatory waves produce superimposed figures for each part of the wave, enabling a distinction to be made between unidirectional and oscillatory voltages.

The klydonograph has been built with multiple elements for simultaneously recording several voltages on a transmission line. It has been developed also with a slowly moving roll film co-ordinated with a recording clock to enable more than one surge to be recorded together with its time of occurrence. In addition rapidly moving film has been used for measuring power-frequency voltages and lightning surges. A better interpretation of the character of the surge can be obtained from positive figures since for the same voltage they are more than twice the size of the negative figure, and the nature of the figure varies more with wave shape. Thus negative surges of less than twice normal line voltage cannot be recorded as they are obliterated by the positive part of the power-frequency record. To overcome this disadvantage, Foust[30] developed an instrument having two elements in parallel, one connected in the opposite polarity to the other so that a positive figure is always obtained. In applying the klydonograph to the measurement of voltages on transmission lines a capacity potential divider is generally used.

The klydonograph has been employed in conjunction with a resistance shunt for the measurement of surge currents and has also been used to measure the maximum rate of rise of current in transmission-line conductors[29] and tower legs[31] by connecting it across a resistance in series with a loop of wire inductively coupled with the main current circuit.

The klydonograph is a relatively simple and inexpensive device, which permits its use in large numbers. It has been valuable in providing statistical data on the magnitude, polarity, and frequency of voltage surges on transmission lines. However, its accuracy in measuring magnitude is only of the order of 25 or 50 per cent and certain interpretations regarding wave shape that have been made with it are questionable.

THE CATHODE-RAY OSCILLOGRAPH

A cathode beam consisting of a stream of electrons emitted from a "cold" cathode and accelerated in an electric field in an evacuated tube was first produced by F. Braun in 1897. Wiechect developed the concentrating coil for beam focusing and the principle of magnetic and electrostatic deflection. In 1913 Zenneck employed the principle of the cathode ray beam to record electrical phenomena. He photographed traces of the beam impinging on a fluorescent screen and deflected by a surge of a few milliseconds duration. This method of recording, however, was not suitable for surges as fast as those produced by lightning. Dufour[32] developed the first cathode-ray oscillograph capable of recording such transients. He increased the recording speed by permitting the beam to impinge directly upon photographic film placed inside the evacuated tube. An oscillograph of this type was first used to study the behavior of artificial lightning surges on a transmission line in the United States by the Westinghouse Electric and Manufacturing Company in 1926, on a five-mile line furnished by the Duquesne Light Company.

Unless the beam is prevented from striking the film until the occurrence of the phenomenon which it is desired to record, fogging of the film results. Norinder[33] overcame this difficulty by means of a special relay, which normally prevented the beam from striking the film but which upon the occurrence of a surge bent the beam around the blocking target. The Westinghouse company[34] employing this relay developed an oscillograph suitable for both field and laboratory work.

Two other schemes have been used to initiate a Dufour

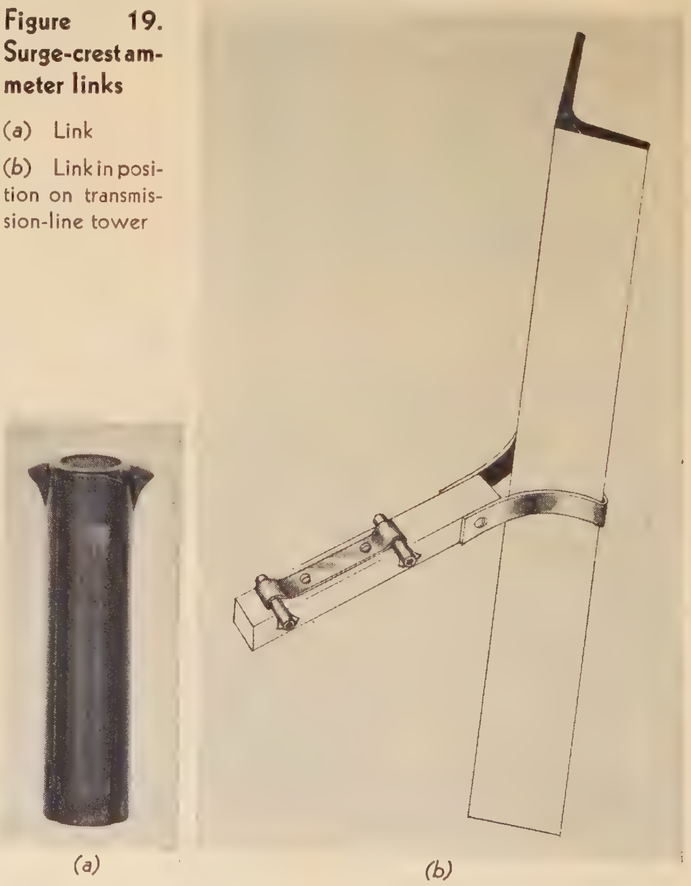

Figure 19. Surge-crest ammeter links

(*a*) Link

(*b*) Link in position on transmission-line tower

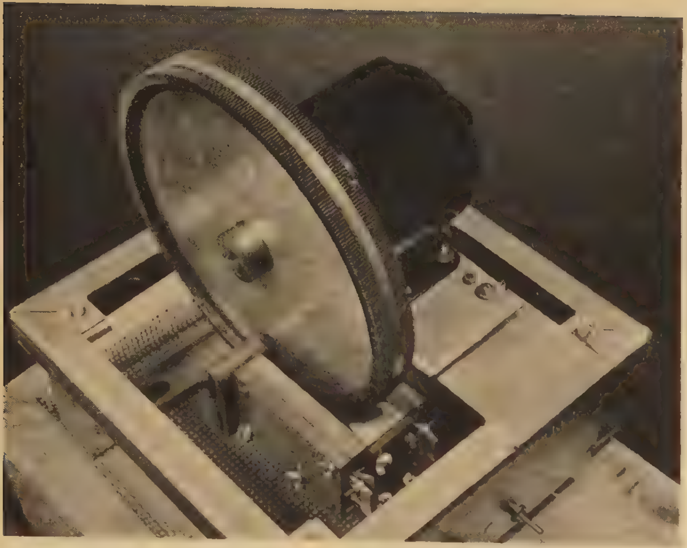

Figure 20. High-speed fulchronograph, showing wheel

type of oscillograph and make it suitable for lightning studies. The General Electric Company[35] developed an oscillograph in which the voltage supply to the cathode was an impulse, from a small surge generator, initiated through a triple gap by the surge to be recorded. George[36] developed a hot-cathode grid-controlled high-vacuum tube.

Oscillographs of the foregoing type employ cathode voltages of about 30 to 40 kv. Having power supplies of such high voltage and being of the pumped type to enable removal of film, they are relatively expensive and delicate in operation and require the constant attendance of an operator. These considerations greatly limit their use in the field, especially in numbers sufficient to obtain data of a statistical nature.

The Radio Corporation of America has developed a sealed-off cathode-ray oscillograph tube that permits sufficient recording speed by means of external photography of the fluorescent screen. Sufficient writing speeds by this method were made possible by its great beam intensity and the development of more sensitive photographic films and faster lenses. A laboratory oscillograph utilizing this tube has been described by Kuehni and Ramo.[37] Being sealed off, this tube lends itself readily to field work, for automatic operation. Wagner and McCann[38] with the co-operation of Ackerman developed a circuit and auxiliary device for use with this tube that permits its placement in the field without the constant attendance of an operator. It is portable and operates from a 110-volt a-c circuit. The tube is of the hot-cathode type and requires a potential of 15,000 volts to accelerate the electron beam which impinges upon a Willamite screen. The image thus produced is photographed. An auxiliary grid within the tube prevents the formation of the electron beam under normal conditions, hence fogging of the film is prevented. On the occurrence of a surge the beam is automatically initiated by the control grid and records the phenomenon.

To measure the voltages on transmission lines a capacity divider is generally used, and for surge currents a resistance shunt, the voltage across the resistance being applied to the oscillograph plates. To cover a wider current range a nonlinear shunt can be used.

PAPER GAPS

A thin piece of paper between two electrodes connected in the lead carrying the surge current has been used to obtain an indication of the magnitude of surge currents.[39,40,41] Tests with surge-generator discharges and 60-cycle currents indicate that the area of the hole produced in the paper is proportional to crest magnitude of current and is independent of wave shape. The effect of a multiple stroke, however, is questionable.

FUSIBLE WIRES

By calibrating different-sized wires connected in series and noting the largest one that fuses,[42] it is possible to obtain an approximate indication of the time integral of the square of the current. One of the first to employ this principle was professor E. C. Starr of Oregon State University, who used it to measure strokes to masts at lightning stations which he established on mountain peaks.

MAGNETIC SURGE-CREST AMMETER

The magnetic surge-crest ammeter developed by Foust and Kuehni[43] provided a simple and inexpensive instrument capable of measuring the crest magnitude and polarity of surge currents. This instrument consists of a small bundle of laminated permanent-magnet steel pieces. It is placed in an unmagnetized condition in the vicinity of a conductor whose current it is desired to measure. The remanent magnetism produced in the steel is a function of the magnitude of the current producing it for unidirectional surges. A special instrument measures the remanent magnetism and is calibrated directly in terms of the original magnetizing current. The polarity of the surge is indicated by the direction of magnetization. This instrument has been used extensively both in the United States and abroad to measure currents in direct strokes; in transmission-line tower legs, ground wires, and phase conductors; in counterpoise conductors and in ground leads of arresters.

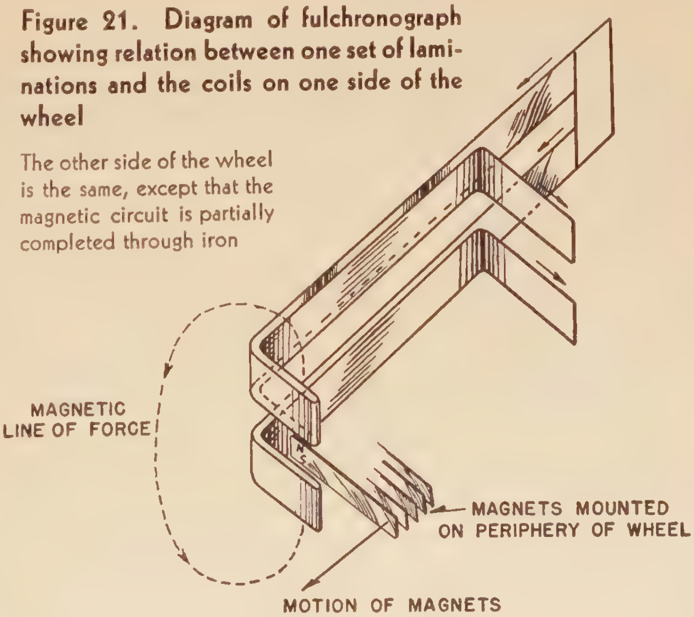

Figure 21. Diagram of fulchronograph showing relation between one set of laminations and the coils on one side of the wheel

The other side of the wheel is the same, except that the magnetic circuit is partially completed through iron

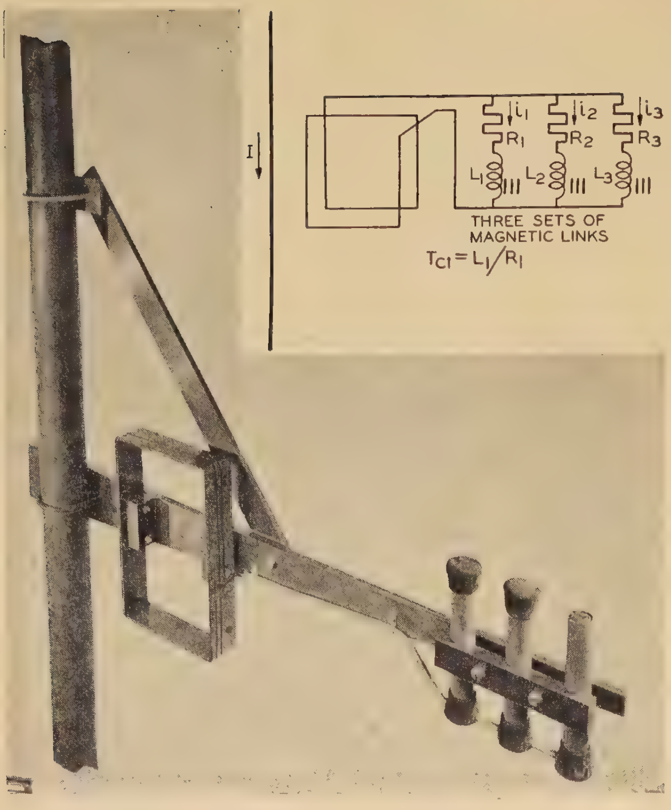

Figure 22. Magnetic surge-front recorder

The magnetic links are usually placed in brackets as shown in figure 19, fastened to the conductor so that their axes coincide with the normal direction of the magnetic lines of force. Several links placed at different distances from the conductor commonly are used to cover a wider range of currents and also to distinguish between unipolarity and oscillatory surges. These instruments being cheap and simple, thousands of them have been used throughout the United States and have provided valuable information relating to lightning currents.

CRATER-LAMP OSCILLOGRAPH

A magnetic oscillograph cannot record faithfully frequencies much above 10,000 cycles per second and cannot record the wave shape or crest magnitude of the initial high-current components of lightning surges. However, it should be able to record the relatively long low-current component and give some information on the total duration and number of components of strokes. Ordinary methods of automatic operation by mechanical relays require about one-half cycle to initiate. However, the crater-lamp oscillograph[44] overcomes this difficulty. It uses a light source consisting of a neon crater lamp, which can be initiated by the transient in about 20 microseconds.

FULCHRONOGRAPH

The cathode-ray oscillograph is the best instrument available from the standpoint of determining wave shape of transients, such as lightning surges. Its cost and complexity, however, limit its use in the field. Because of the variable character of lightning, it is important to obtain sufficient data to determine the statistical nature of its properties. The klydonograph and surge-crest ammeter have provided data of this type on the magnitude and polarity of surge voltages and currents. The number of components, wave shape, and duration of surges are of even more importance, however, and it was with the view of gathering data on these properties of surges that the Westinghouse Electric and Manufacturing Company[38] developed a number of new recording instruments. The most important of these is the fulchronograph,* a device capable of measuring the wave shape and duration of the tail of current surges, but cheap enough, and simple enough in its operation to be used in large quantities in the field.

The essential part of the fulchronograph is a slotted aluminum rotating wheel. In a "high-speed" fulchronograph, figure 20, the wheel turns at 3,450 rpm, and in the "slow-speed", with the speed of approximately 60 rpm. In the rim of each are 408 laminations of permanent magnet steel nine mils thick, projecting from each side. The laminations pass between narrow coils (see figure 21) through which flows the current to be measured. As a particular set of laminations spans the gap between the coils, they are subjected to a radial magnetizing force proportional to the current at that instant. By measuring the retentivity or residual flux in the laminations it is possible to reconstruct a graph of the current as a function of time. The device functions in a manner similar to the surge-crest ammeter except that time has been introduced by the rotation of the wheel.

By placing a high-speed and a low-speed fulchronograph together in series and running them continuously, greater wave detail and a longer period of time can be covered than by the use of either one separately. The high-speed unit in one revolution divides 17,000 microseconds into 43-microsecond intervals, the low-speed unit in one revolution divides 1 second into 1/400 second intervals. Multiple-stroke discharges rarely last longer than one second, or have time intervals between strokes of more than 0.5 second. These facts make it possible with the data provided by the two wheels to resolve a surge into its multiple components and to obtain the wave magnitude and shape of each.

MAGNETIC SURGE-FRONT RECORDER

The principal disadvantage of the fulchronograph is its inability to measure the high rates of rise of the front of the waves. Devices for measuring the maximum rate of rise have been available for some time. As mentioned previously, the klydonograph can be used to indicate the maximum rate of rise on the front of lightning-current surges. Probably of greater importance than the maximum rate of rise is the average rate of rise, such as can be defined by a straight line drawn through the 10 per cent and 90 per cent of crest value.

The magnetic surge-front recorder which, with a schematic diagram, is shown in figure 22 is a device for recording this property of lightning currents. It consists of

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*This name was obtained as a combination of the Latin word *fulmen*, meaning lightning, and the Greek words *chronos*, meaning time, and *graphein*, meaning to write three circuits containing resistance and inductance having different time constants. They are connected across an inductance carrying the main surge current or a loop inductively coupled with the circuit carrying the main surge current. Magnetic links placed within the field of the inductors of these three circuits serve to record their maximum currents $i_{\max}$. The introduction of an appreciable time constant T_c into these circuits prevents the currents in them from responding to instantaneous changes in the main current, thus substantially eliminating the effect of high-frequency oscillations in the front of the wave. If these resistors were not present, the current in the auxiliary coils at all times would be proportional to the rate of change of the main surge current and the maximum current in them would be proportional to the maximum rate of rise of current on the front of the main surge.

When inductance is added to the auxiliary circuits, the maximum current in any one of them is proportional to the average rate of rise of the main surge current over a definite range. Three of these circuits are adequate to cover the desired range of time to reach crest.

MAGNETIC SURGE INTEGRATOR

The magnetic surge integrator is a relatively simple and inexpensive device for recording the total charge or the integral of the current in a lightning surge. It consists essentially, as shown by the schematic diagram of figure 23*a*, of a noninductive shunt that carries the main surge current, and across which an inductor is connected. Neglecting the resistance of the inductor, its current at any instant is equal to the time integral of the main surge current, and, if the surge is nonoscillatory, the final maximum value of this current is the total integral of the main surge current. To cover a wide range, three magnetic links are placed at different points within the magnetic field produced by the coil. The magnetic field that magnetizes the links is a function of the coil current. Thus from a measurement of the remanent magnetism in the links a record of the total charge in the surge is obtained. The effect of the resistance of the coil is to limit the time for which the response is an accurate measure of the integral of surge current. If two coils having different time constants are used it is possible, in addition to measuring the charge, to form some idea of the wave shape. The two time constants are adjusted so that one coil can measure accurately up to 10,000 microseconds (figure 23*b*) and the other up to 300 microseconds. This type of integrator forms, with the magnetic surge-front recorder and surge-crest ammeter, a good, inexpensive combination, especially where power is not available.

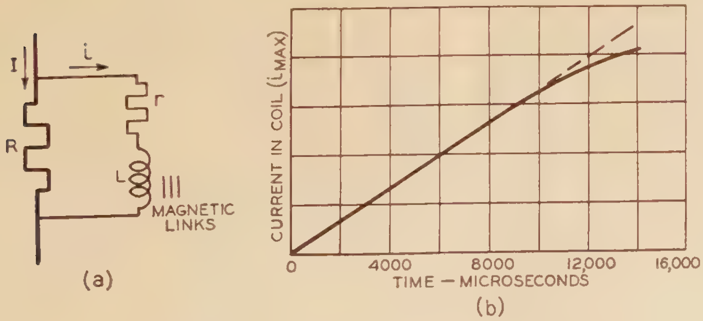

Figure 23. Magnetic surge integrator

(*a*) Schematic diagram
(*b*) Response curve

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43. The Surge-Crest Ammeter, **C. M. Foust** and **H. P. Kuehni.** *General Electric Review*, volume 35, 1932, page 644.

44. The Crater-Lamp Oscillograph, **W. A. McMorris, M. A. Rusher,** and **J. H. Hagenguth.** *General Electric Review*, volume 37, 1934, page 514.

Highway Lighting and Traffic Capacity. Not only increased safety but added capacity for traffic is conferred on highways by adequate lighting. This seems proved by a report by W. P. Walker, assistant highway economist of the Public Roads Administration, published in "Highway Research Abstracts", December 1940.

On a well-lighted highway, it was found, drivers seized opportunities for safely passing a slower vehicle approximately as often as by daylight, but with the highway unlighted only two-thirds as many opportunities were utilized. Consequently the tendency for traffic to collect behind a slowly moving vehicle was increased and road capacity thus was reduced.

On the unlighted highway drivers tended to edge over toward the center of the road, thus reducing its effective width. Adequate lighting, making clear the position of the curb, kept the cars in their normal daylight positions.

"Illumination Note" contributed for the AIEE committee on production and application of light by L. A Hawkins (A'03, M'13) executive engineer, research laboratory, General Electric Company, Schenectady, N. Y.

Institute Activities

South West District Meeting Will Be Held at St. Louis, October 8–10

A DIVERSIFIED PROGRAM has been arranged for the South West District meeting to be held at St. Louis, Mo., October 8–10, 1941. Seven technical sessions, a technical conference, and a general session are planned, in addition to various trips, sports, and entertainment. Meeting headquarters will be at the Coronado Hotel, which is centrally located and specializes in convention accommodations.

TRIPS

Three types of trip—sight-seeing, inspection, and special—are planned. Advance registration for the sight-seeing trips is desirable although not essential. All industrial trips are limited to United States citizens and, where indicated, to AIEE members. The special trips will be made only if sufficient numbers are interested. They will be scheduled at times to suit the majorities. Because of National Defense regulations industrial trips require registration in advance of October 1. A card for this purpose will be sent to all members of the South West District and near-by territory.

Sight-Seeing Trips. A general tour of St. Louis will be made on Wednesday afternoon to see the New Cathedral, Lindbergh trophies, famous Art Hill, zoo and bear pits, Jewel Box, Aloe Plaza and Milles Fountain, Memorial Plaza and Municipal and Federal Building Group, site of new Jefferson Memorial (Riverfront) Plaza, Christ Church Cathedral, St. Louis University, and many other points of interest.

Another special-interest tour, especially for women although men also are invited, will be made on Thursday morning to the Art Museum, world-famous Shaw's Garden, the home of Eugene Field, and the Old Cathedral, built in 1840.

Inspection Trips. Three trips have been arranged for Thursday afternoon. Members may choose to visit power plants, Washington University, or the Beaumont telephone office. Each of these trips includes a visit to the Anheuser-Busch brewery.

One trip includes the new Venice and Cahokia power plants of the Union Electric Company. The new Venice power plant is now under construction and will have an ultimate capacity of 400,000 kw. Two 40,000-kw turbogenerators and two pulverized fuel boilers are to be placed in service late this year. The Cahokia power plant has 6 turbogenerators and 24 pulverized fuel boilers, total capacity 300,000 kw. New fly-ash precipitators are in operation on one of six stacks. This trip is limited to AIEE members.

The Anheuser-Busch brewery, included on each of the three trips, had an estimated 1941 production of 3,000,000 barrels of beer. Corn products, baker's yeast, and refrigerated cabinets are also manufactured. The power plant, brew house, bottling plant, and the reception room may be visited.

A second trip will be arranged to Washington University to see the new Cyclotron and make a tour of the other buildings. The Cyclotron is the second largest in the country, with an 80-ton electromagnet, 12-ton cooling coils, and a radio-frequency oscillator of 50 kw at a frequency of 11,000,000 cycles. The schools of architecture, fine arts, liberal arts, engineering, law, business and public administration and graduate studies are on a beautiful campus. Women guests are invited on this trip.

The third trip offered will be to the Beaumont telephone office, where the toll exchange of the Southwestern Bell Telephone Company and the long lines department of the American Telephone and Telegraph Company are located. Here may be seen operators at a 250-position long-distance switchboard, wire-photograph transmission equipment, telephone carrier equipment, teletypewriter switchboard, telegraph composite equipment, radio-transmission switching, and other testing equipment.

Three trips also are planned for Friday afternoon. The first consists of a radio tour, on which women also are invited. The second will be taken to a substation and a transformer manufacturing plant, and the third will be a tour of the a-c network of the Union Electric Company. The last two trips are limited to AIEE members.

On the radio tour transmitting station KWK, broadcasting station KMOX of the Columbia Broadcasting System studios, and frequency modulation station and radio dispatcher's room of the St. Louis Public Service Company will be visited. Station KWK operates on 5,000 watts at a frequency of 1,370 kilocycles with a half-wave vertical antenna. The 50,000-watt station KMOX operates at a frequency of 1,110 kilocycles and is the point of origin for many chain programs. This station has modern sound and technical equipment for producing and receiving major chain programs. The frequency-modulation station is a two-way system for street-railway and bus dispatching and communication with supervisors' cars and emergency trucks. This station consists of a 250-watt transmitter, 250-foot tower, remote-control radio console and street-car headway recorders to indicate passage of cars at various points on the system.

The second trip will be to the Page Avenue substation of the Union Electric Company and the transformer manufacturing plant of the Moloney Electric Company. The substation is an interconnection point between 25-cycle and 60-cycle systems and is an important switching center for a major transmission loop. Three 20,000-kw variable-ratio automatically controlled frequency changers, 416,500 kva of transformer capacity are installed. In the plant of the Moloney Electric Company many classes of transformers are manufactured, ranging from power sizes of 30,000 kva, 161,000 volts to the distribution sizes. Testing equipment includes a 2,500,000-volt surge generator.

On the tour of the new a-c network system of the Union Electric Company may be seen 500-, 750-, and 1,000-kva, 13,800 ÷ 120–208-volt network units, including network protectors and primary three-way grounding switches; specially designed network relay test board; miniature of complete system, comprising network calculating board; distribution trouble dispatching office; and system load dispatching office.

Special Trips. If a sufficient number are interested, the following trips may be arranged at a time to suit the majority.

A trip to inspect the newest model PCC street cars of the St. Louis Public Service Company may be arranged. The general shops are equipped with new inspection bays, which have specially designed overhead and pit lighting. A special motor-generator set also is employed to make possible relay and line-breaker settings over a wide range.

A trip also may be arranged to inspect three distribution substations of the Union Electric Company. The Tenth Street substation is one of the largest of the company's d-c substations, automatically operated, with a capacity of 7,850 kw. The Fifteenth Street substation is the newest d-c substation, equipped with an 1,800-kw motor-generator set and a 2,250-kw rotary converter, unattended. The Carondelet substation supplies the 4,500-volt distribution system and is equipped with two 13,333-kva 33/4.5-kv transformers, five 3,900-kva regulated outgoing feeders. The equipment of this station is of unusual steel cubicle design. If arranged, this trip will be limited to AIEE members.

Another possible trip may be arranged to inspect the electric-arc furnaces of the St. Louis Steel Casting Company, where 800- and 1,500-kva, 13-kv, three-phase "Lectromelt" furnaces are in operation. These furnaces have automatically operated carbon electrodes. The pouring of steel castings, as well as other interesting foundry operations, may be seen.

Still another possible trip may be arranged to a steel mill of the Granite City Steel Company, which has continuous hot and cold strip mills of recent installation. D-c drives and control are supplied from large motor-generator sets. The mill has two 7,500-kw turbogenerators and a steam power plant.

ENTERTAINMENT

Wednesday afternoon a bridge party for women guests will be given at the Park Plaza Hotel. After bridge there will be a

South West District Meeting Program

Wednesday, October 8

9:00 a.m. Registration

10:00 a.m. General Session

Opening address of welcome. J. L. Hamilton, vice-president, South West District

Address, "Electric Utilities' Part in National Defense." E. T. Gushee, executive vice-president, Union Electric Company of Missouri

Address, "St. Louis a Clean Place to Live." Raymond Tucker, past director of smoke abatement

2:00 p.m. Selected Subjects

41-152. A Novel Reclosing Relay. **P. O. Bobo**, Oklahoma Gas and Electric Company

41-153. Symmetrical Nomenclature of Three-Phase Circuits. **Bryce Brady**, Oklahoma Gas and Electric Company

41-141. Lightning Strokes in Field and Laboratory—III. **P. L. Bellaschi**, Westinghouse Electric and Manufacturing Company

2:00 p.m. Transformers

DP.* Trends in Design of High-Voltage Power Transformers. **W. C. Sealey**, Allis-Chalmers Manufacturing Company

DP.* Modern Load-Ratio Control Transformers. **F. W. Bush**, Allis-Chalmers Manufacturing Company

DP.* Calculation of Transformer Temperatures Under Overloads. **R. H. Jones, Jr.**, Moloney Electric Company

DP.* Current Distribution and Transformer Winding Containing a Short Circuit. **H. Weichsel** and **W. L. J. F. Godin**, Wagner Electric Corporation

41-159. High-Pressure Gas as a Dielectric. **G. C. Nonken**, General Electric Company

Thursday, October 9

9:30 a.m. Electrical Machinery and Power Generation

41-160-ACO.** 160,000 Kw at Venice Plant Number 2, Union Electric Company of Illinois. **R. R. Wisner**, Stone and Webster Engineering Corporation, and **Stanley Stokes**, Union Electric Company of Missouri

41-158. A Turbine Governor Performance Analyzer. **W. O. Osbon**, Westinghouse Electric and Manufacturing Company

41-161-ACO.** Experimental and Operating Data on Vibration and Sound Level in Two-Pole Generators. **J. W. Batchelor** and **H. E. Criner**, Westinghouse Electric and Manufacturing Company

●PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in this program may be obtained as noted in the following paragraphs.

●ABSTRACTS of papers appear on pages 446–8 of this issue, pages 406–07 of the August 1941 issue, and for paper 41-105 page 290 of the June 1940 issue of Electrical Engineering.

●PRICES and instructions for securing advance copies of these papers accompany the abstracts. Mail orders are advisable, particularly from out-of-town members as an adequate supply of each paper at the convention cannot be assured. Only numbered papers are available in pamphlet form.

●COUPON books in $5.00 denominations are available for those who may wish this convenient form of remittance.

●ALL PAPERS regularly approved by the technical program committee ultimately will be published in Transactions; many will appear also in Electrical Engineering.

DP.* Methods of Obtaining Variable Speeds. **A. F. Hartung**, Burns and McDonnell Engineering Company

9:30 a.m. Transmission and Distribution

DP.* Application of Telemetering and Automatic Tie-Line Load Control to Interconnected System Operation. **M. J. Thrasher**, Texas Power and Light Company

DP.* Design and Application of Fuse Links for Use in Fiber Tube Cut-Outs. **L. L. Crump**, James R. Kearney Corporation

41-151-ACO.** Design Features of a New High-Capacity Network Protector. **J. W. Seaman** and **R. W. Smith**, General Electric Company

Friday, October 10

9:30 a.m. Communication and Radio

DP.* How Crosstalk Affects Toll-Cable Installation Methods. **A. G. Chapman**, Bell Telephone Laboratories, Inc.

41-149. The Communication Facilities of the United States Forest Service. **A. G. Simson**, Forest Service, U. S. Department of Agriculture

DP.* Conductor Radio, an Innovation in Nonreturn Circuits. **J. D. Browder**, Oklahoma Gas and Electric Company

41-105. Diode Rectifying Circuits With Capacitance Filters. **D. L. Waidelich**, University of Missouri

DP.* Selenium Rectifiers and Principles of Their Design. **J. E. Yarmack**, International Telephone and Radio Manufacturing Corporation

9:30 a.m. Motors

41-154. The Inherent Overheating Protection of Single-Phase Motors. **C. P. Potter**, Wagner Electric Corporation

41-157. The Equal-Volt-Ampere Method of Designing Capacitor Motors. **P. H. Trickey**, Riehl Manufacturing Company

41-162. The Apparent Impedance Method of Calculating Single Phase Motor Performance. **W. J. Morrill**, General Electric Company

2:00 p.m. Conference on Motors

CP.† Report on General Principles for Rating of Electrical Apparatus for Short Time, Intermittent or Varying Duty. **P. L. Alger**, chairman, AIEE Co-ordinating Committee number 4, Basic Principles for Rating of Electrical Machinery and Apparatus.

CP.† Development of Polyphase Rotors. **Martin Schiff**, Century Electric Company

CP.† Purifying and Cleaning of Hermetic Motor Parts. **A. C. Dickson**, Emerson Electric Manufacturing Company

2:00 p.m. Electrical Instruments

41-156. A Cathode-Ray Method of Wave Analysis. **V. O. Johnson**, Westinghouse Electric and Manufacturing Company

41-155. A Cathode-Ray Oscillograph With Rotating Drum Camera. **E. G. Downie**, General Electric Company

41-143. The Modern A-C Network Calculator. **W. W. Parker**, Westinghouse Electric and Manufacturing Company

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*DP: District paper, for which no advance copies are available; not intended for publication in Transactions.

**ACO: Advance copies only available; not intended for publication in Transactions.

†CP: Conference paper; no advance copies are available; not intended for publication in Transactions.

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dinner and floor show for women only.

Wednesday evening from 7:30 to 9:30 p.m. there will be a smoker for the men in the Coronado Hotel, with a four-piece orchestra and other entertainment. Tickets are $1.50 each; for students, $1.00.

Thursday noon a luncheon will be arranged for all those attending the meeting. Talks will be given by President D. C. Prince and National Secretary H. H. Henline. Doctor William McClellan, a past president of the AIEE, will preside.

Thursday evening a banquet and dance will be held. There will be music during the dinner, and other entertainment. Students who do not desire to attend the dinner are invited to attend the dance without cost.

SPORTS

St. Louis has a number of golf courses and the committee will make arrangements upon request for any who wish to play. Because of the limited time of the meeting there will be no tournament. The committee also will be glad to direct anyone to the many bowling alleys which are available.

On the Saturday following the meeting there will be a football game, Oklahoma A. and M. College against Washington University at the Washington University stadium in St. Louis. Arrangements will be made for special rates to AIEE members.

MEETINGS

The executive committee of the South West District will meet on Thursday, October 9, at 2:00 p.m. A meeting of Branch Counselors also will be scheduled later by Chairman R. S. Glasgow.

COMMITTEES

District meeting committee members are:

J. L. Hamilton, vice-president, South West District; L. L. Crump, secretary, South West District. L. O. Campbell, F. A. Decker, R. S. Glasgow, R. B. Gow, J. S. Johnson, R. G. Meyerand, H. R. Pearson, and W. B. Stephenson.

Chairmen of subcommittees are:

G. A. Waters, *general committee;* R. S. Glasgow, *student activities;* F. A. Cooper, *meetings and papers;* Lee Washington, *hotels and registration;* L. L. Crump, *publicity and attendance;* O. J. Rotty, *inspection and transportation;* C. B. Hall, *finance;* E. S. Rehagen, *entertainment;* Mrs. L. O. Campbell, *women's entertainment.*

Additional 1940 District Prize

District 2

Prize for Branch paper was awarded to George J. Thaler for his paper "Characteristics of Fluorescent Lamps," presented at a student meeting of the Maryland Section, held at The Johns Hopkins University, Baltimore, Md., April 29, 1940.

National

AIEE Committee Changes

One Institute general committee has been abolished and two others merged into a third by recent action of the AIEE board of directors. The committees on economic status of the engineer and on legislation affecting the engineering profession have been consolidated into the committee on Institute policy, which will carry on their activities through subcommittees. The committee on Columbia University scholarships has been abolished, because funds for the scholarships are not available.

Board of Directors Meets

The regular meeting of the AIEE board of directors was held at Institute headquarters, New York, N. Y., August 8, 1941.

Upon recommendation of the publication committee, authorization was given for issuing as a special Institute publication, on a self-supporting basis, a "Bibliography on Circuit Breakers, Switches, and Fuses, 1928–40," which had been prepared by the committee on protective devices.

The appointment by the president of committees of the Institute for the administrative year beginning August 1, 1941, was announced (for complete list of officers and committees for 1941–42 see pages 453–7).

It was voted to consolidate the committee on economic status of the engineer and the committee on legislation affecting the engineering profession into the Institute Policy committee, which will carry on their various activities through the necessary subcommittees.

Because the scholarships will not be available for the coming year at least, it was decided to abolish the committee on Columbia University scholarships.

In accordance with recommendations of the standards committee, the board approved the following:

Revised American Standard for Letter Symbols for Hydraulics, Z10b

Revised American Standard for Letter Symbols for Mechanics of Solid Bodies

Revised American Standard for Illuminating Engineering Nomenclature and Photometric Standards

A report by W. S. Mallory, secretary, of the activities, accomplishments, and dissolution of The Thomas Alva Edison Foundation (on which the Institute had four representatives) was presented. The national secretary was directed to acknowledge the report, and to transmit to W. S. Barstow, president of the Foundation, the Institute's appreciation of his outstanding contributions to the activities of the Foundation.

Future AIEE Meetings

South West District Meeting
St. Louis, Mo., October 8–10, 1941

Southern District Meeting
New Orleans, La., December 3–5, 1941

Winter Convention
New York, N. Y., January 26–30, 1942

The following appointments by the president, upon recommendation of the standards committee, were approved:

H. M. Turner as AIEE representative on and chairman of the Sectional Committee Z10, Letter Symbols and Abbreviations for Science and Engineering

L. V. Winchester as AIEE representative on a proposed Sectional Committee on Safety Code for Quarry Operation

Various representatives of the Institute on other bodies were appointed for the year beginning August 1, 1941; also the following were reappointed:

J. F. Fairman on the Engineers' Council for Professional Development, for the term of three years beginning in October 1941

W. I. Slichter on the Library Board of United Engineering Trustees, Inc., for the four-year term beginning in October 1941

F. Malcolm Farmer on the Board of Trustees of United Engineering Trustees, Inc., for the 4-year term beginning in October 1941

L. W. Chubb on the Research Procedure Committee of The Engineering Foundation for the term of one year beginning in October 1941

Local honorary secretaries of the Institute were reappointed for the two-year term beginning August 1, 1941, as follows:

A. P. M. Fleming for England
P. H. Powell for New Zealand
A. F. Enstrom for Sweden
Richard H. Bowles for Brazil

Appointment by the president of R. N. Conwell, I. Melville Stein, and S. B. Williams as members of the Lamme Medal committee for the three-year term beginning August 1, 1941, was confirmed.

The board confirmed the appointment by the president of N. E. Funk as chairman for the year beginning August 1, 1941, and J. T. Barron, R. E. Doherty, and J. V. B. Duer as members of the Edison Medal committee for the term of five years. From its own membership, the board elected M. S. Coover, Mark Eldredge, and R. W. Sorensen as members of the Edison Medal committee for the two-year term beginning August 1, 1941.

The board confirmed the appointment by the president of W. F. Davidson and D. F. Miner as members of the Charles LeGeyt Fortescue Fellowship committee for the term of three years beginning August 1, 1941.

Other actions taken by the board included the following:

Minutes of the meeting of the board of directors held on June 18, 1941, were approved.

Recommendations adopted by the board of directors at its meeting held on July 10, 1941, were presented and approved.

Upon recommendation of the board of examiners, the following actions were taken: 1 applicant was elected and 1 was transferred to the grade of Fellow; 52 applicants were transferred and 24 were elected to the grade of Member; 182 applicants were elected to the grade of Associate; 30 Students were enrolled.

Expenditures in July, amounting to $27,366.50, were reported by the finance committee and approved.

Those present were:

President—David C. Prince, Schenectady, N. Y.

Past President—F. Malcolm Farmer, New York, N. Y.

Vice-Presidents—J. L. Hamilton, St. Louis, Mo.; N. S. Hibshman, Bethlehem, Pa.; J. Elmer Housley, Alcoa, Tenn.; Everett S. Lee, Schenectady, N. Y.; C. A. Price, Hamilton, Ont.; Walter C. Smith, San Francisco, Calif.; A. LeRoy Taylor, Salt Lake City, Utah.

Directors—M. S. Coover, Ames, Iowa; Lester R. Gamble, Spokane, Wash.; T. G. LeClair, Chicago, Ill.; L. R. Mapes, Chicago, Ill.; Fred R. Maxwell, Jr., Pensacola, Fla.; W. B. Morton, Philadelphia, Pa.; H. S. Osborne, New York, N. Y.; R. G. Warner, New Haven, Conn.

National Treasurer—W. I. Slichter, Schenectady, N. Y.

National Secretary—H. H. Henline, New York, N. Y.

Section

New York Group to Sponsor Lectures on Nonlinear Theory

During the winter of 1941–42, the basic science group of the AIEE New York Section will offer a series of lectures on nonlinear circuit theory. One object of these lectures is to present to the electrical engineer the more important analytical and graphical methods of solving nonlinear equations used in both the power and communication fields. Another object is to stimulate further interest and research on the subject. Some of the lecturers may introduce unpublished material of interest. The lectures are to be simplified and coordinated on the assumption that the listeners have had no special mathematical training.

This new series will supplement that sponsored by the basic science group in 1940–41. Given as a symposium on advanced mathematics, those five lectures proved to be of sufficient general interest that the lecturers were asked to contribute articles on their several topics to ELECTRICAL ENGINEERING. The first article "Heaviside's Direct Operational Calculus" is scheduled to appear in an early issue. Other articles on integration in the complex plane, Laplacian transformation, Fourier integrals, and traveling waves on transmission lines will appear in subsequent issues in their original order of presentation. At the completion of publication of the series, a composite reprint booklet is expected to be issued at a nominal price for the convenience of all who may be especially interested in the subject.

Abstracts

TECHNICAL PAPERS are previewed in this section as they become available in advance pamphlet form. Copies may be obtained by mail by remitting price indicated to the AIEE order department, 33 West 39th Street, New York, N. Y.; or at five cents less per copy if purchased at AIEE headquarters or at AIEE convention or District-meeting registration desks.

The papers previewed in this issue will be presented at the AIEE South West District meeting, St. Louis, Mo., October 8–10, 1941.

Basic Sciences

41-159—High-Pressure Gas as a Dielectric; *Gordon C. Nonken (A'36). 15 cents by mail.* Impulse and 60-cycle breakdown strength of sphere gaps, rod gaps, and of solid fluid built-up samples are reported in this paper. The tests were made in nitrogen up to 200 pounds per square inch gauge pressure and in Freon up to 70 pounds per square inch gauge pressure. Dielectric strength values were compared with the breakdown of transformer oil under similar conditions. Gap conditions were found for which the 60-cycle breakdown of a gas was twice its impulse strength. Whereas gases under pressure have greater 60-cycle breakdown strength than transformer oil under some conditions, under the same conditions the oil has the greater impulse-breakdown strength.

Electrical Machinery

41-154—The Inherent Overheating Protection of Single-Phase Motors; *C. P. Potter (F'29). 15 cents by mail.* "Inherent overheating protective devices," ordinarily known as "motor protectors," are selected for application on single-phase motors in accordance with the requirements of the Underwriters' Laboratories (Industrial Control Equipment, appendix pages 26A, 26B, 26C, and 26D). The tests specified by the Underwriters' Laboratories are relatively simple and are made at normal frequency, at approximately normal voltage, at ordinary room temperatures, and with free motor ventilation. This paper reports the results of special tests which were made at abnormal voltages, abnormal frequencies, high ambient temperatures, and with restricted ventilation, to determine whether a single-phase motor equipped with a protector which meets the Underwriters' tests can have hazardous winding temperatures under any operating conditions. The author arrived at the conclusion "that inherent overheating protective devices mounted inside fractional-horsepower single-phase motors completely protect them against all abnormal operating conditions."

41-157—The Equal-Volt-Ampere Method of Designing Capacitor Motors; *P. H. Trickey (M'36). 15 cents by mail.* An improved method of designing capacitor motors has been devised, based on a method developed by the author and described in a previous paper, "The Design of Capacitor Motors for Balanced Operation" (*AIEE Trans., vol. 51, 1932, p. 780–5*). The new method has the same general advantages of simplicity and ease of performance calculation as the "balanced" method, but results in a motor with a less expensive capacitor. It consists in calculating a "balanced" motor then modifying the design in a certain specified manner which does not materially affect the performance. Curves are given showing how departure from the "balance point" by the "equal-volt-ampere" method affects the no-load, full-load, and starting performance, and the maximum and locked rotor torques.

41-161-ACO.—Experimental and Operating Data on Vibration and Sound Level in Two-Pole Generators; *J. W. Batchelor (A'38) and H. E. Criner. 15 cents by mail.* Double-frequency vibration of a two-pole rotor is caused by unequal rigidity about the pole center line, and the axis perpendicular to this center line. In addition, the air-gap flux is responsible for unequal magnetic attraction along the two axes, causing the stator to distort. The distorted stator takes the form of an ellipse which rotates with the field, and causes the 120-cycle vibration at normal running speed. Correction for rotor vibration consists of cutting transverse slots in the poles to equalize the rigidity. The effect of the stator vibration is minimized by isolating the core. This paper reviews the methods used in reducing double-frequency vibration and sound level at points exterior to the generator frame. Data taken in the shop and field on comparable machines show how effective the methods are in obtaining the desired reduction.

41-162—The Apparent-Impedance Method of Calculating Single-Phase Motor Performance; *Wayne J. Morrill. 15 cents by mail.* In the past several years there have been offered a number of calculation methods to be used in connection with predetermining the performance of single-phase induction motors. While such methods are usually based upon either the cross-field or the revolving-field theory, they differ from each other according to individual preferences. In the present paper there is proposed a method which seems to be convenient and simple, and which, because of symmetry, involves a minimum of charts in carrying out the necessary calculations. The method is proposed because it has been used in one design department for a number of years and found to be very satisfactory as a practical method.

Instruments and Measurements

41-155—A Cathode-Ray Oscillograph With Rotating-Drum Camera; *E. G. Downie (A'35). 15 cents by mail.* The study of operation of certain high-voltage, low-current equipment, such as the luminous-tube transformer, requires the use of the cathode-ray oscillograph. It is desirable to record on film recurring or nonrecurring waves viewed on the cathode-ray screen, and to compare phase angles of any number of current or voltage waves. A cathode-ray oscillograph and rotating-drum camera have been developed to meet these needs. Images on the short persistence screen are recorded on 35 mm film in a rotating-drum camera focused on the screen and driven by a synchronous motor. A reference point of time or phase position is provided on successive exposures by a small, very sharp voltage peak, occurring each half-cycle, superimposed on the original wave. A convenient spring drive is also provided on the camera drum for exposures at various film speeds, with a single revolution of the drum.

41-156—A Cathode-Ray Method of Wave Analysis; *Vincent O. Johnson (A'39). 15 cents by mail.* Complex periodic functions, when transformed into corresponding voltage waves, may be analyzed with the use of a cathode-ray oscillograph. The complex wave is represented upon the fluorescent screen of the cathode-ray tube by a vertical displacement at the same time that a sinusoidal horizontal oscillation exists. If the frequency of the sinusoidal oscillation bears an integral relation to the fundamental frequency of the complex wave, a Lissajous figure is viewed on the screen. The areas of these Lissajous figures are directly related to the coefficients of the Fourier series for the complex wave. The area is determined by measuring a photograph of the figure, using a polar planimeter. The method is based on the theory developed by L. W. Chubb in connection with the Chubb Polar Analyzer.

Power Generation

41-158—A Turbine-Governor-Performance Analyzer; *W. O. Obson (M'41). 15 cents by mail.* Numerous papers and discussions at recent meetings of the AIEE and ASME have revealed an urgent need for means of measuring turbine-governor performance. Instruments for making such measurements have been developed and are described in detail. These include means for measuring and simultaneously recording the following four quantities: (1) generator load; (2) turbine speed in terms of generator or system frequency; (3) turbine steam-valve travel; and (4) various hydraulic pressures within the governor. The instruments are characterized by their high sensitivity and by their ability to follow changes many times more rapid than can be followed by previous recording instruments.

41-160-ACO—160,000 Kw at Venice No. 2 Plant of Union Electric Company of Illinois; *R. R. Wisner (A'23) and Stanley Stokes (F'29). 30 cents by mail.* This paper presents the fundamental requirements to be met in providing additional power supply for the St. Louis area. In order to meet these requirements the Venice site is being developed with an initial installation of 160,000 kw and a planned ultimate capacity of about 400,000 kw. The installed capacity consists of two 40,000 kw and one double-winding 80,000 kw, 13.8-kv generator. Steam is provided at 850 pounds per square inch and 900 degrees Fahrenheit by two 360,000-pound-per-hour and two 375,000-pound-per-hour boilers. The bus arrangement is such as to provide direct connection from generators to feeders and through the use of transfer and synchronizing busses to provide for the supply of power to the transmission system or from the transmission system to the feeders. Bus sectionalizing and reactors limit the short circuit duty to less than 2,500,000 kva on the synchronizing bus-sectionalizing breakers and less than 1,500,000 kva on all other breakers. Bus-differential protection is provided. All station auxiliaries are electrically driven.

Power Transmission and Distribution

41-153—Symmetrical Nomenclature of Three-Phase Circuits; *Bryce Brady (M'37). 15 cents by mail.* Two methods of identifying three-phase conductors, voltages, and currents are in general use today. One method, which is called "standard" nomenclature because of its extensive use on power transmission and distribution systems, is based on the 30 degree relation between delta and wye voltage. The other method, which is frequently used for analytical purposes and is called "symmetrical" nomenclature, is based on the 90 degree voltage relation. Shortcomings of the standard scheme and five advantages of the symmetrical plan are discussed.

Protective Devices

41-151-ACO—Design Features of a New High-Capacity Network Protector; *J. W. Seaman (A'32) and R. W. Smith (A'40). 15 cents by mail.* The investigation of ways and means to produce a new high-capacity network protector, suitable for the interrupting and carrying of currents greater than those heretofore encountered in the network field, has resulted in the introduction of a device containing new and interesting features. Chief of these is the use of a new multiple-point contact construction which has distinct advantages over contacts formerly used, from a current-carrying, current-transferring, current-interrupting, and contact-pressure standpoint. The methods employed to obtain data are described. The relationship between various numbers of point contacts in multiple and the consequent change in current limitations are shown. The data obtained provide a basis for the design of contacts suitable for coping with any specified transient current.

41-152—A Novel Reclosing Relay; *P. O. Bobo (M'41). 15 cents by mail.* A reclosing relay, consisting of an assembly of telephone-type relays and designed with features that are not obtainable with standard reclosing relays now available, is used by the Oklahoma Gas and Electric Company to meet the additional reclosing requirements brought about by complete automatization of high-voltage oil circuit breakers in transmission networks and on lines containing automatic sectionalizing airbreak switches. The most important requirements for reclosing relays in such applications are the ability to distinguish between energized and de-energized line conditions, to be fast and accurate in timing between reclosures, and to reset quickly after successful reclosures. It is through the fulfillment of the additional requirements that the relay permits a transmission system to render maximum continuity of service.

Standards • • •

Proposals Offered for the Rating of Electrical Apparatus

As a preliminary step in the current development of a proposed AIEE Standard covering the principles of reading electrical apparatus for short-time, intermittent, or varying duty, the subject is scheduled to be discussed in a technical session and conference at the forthcoming South West District meeting in St. Louis, Mo., October 8–10, 1941. The following is a digest of the Report (AIEE No. 1A) on this topic prepared by the AIEF standards co-ordinating committee No. 4.

There are two distinct limitations on the available output of electrical apparatus. One is the peak-load ability, as fixed by the breakdown torque, commutation limit, reactance, or fall-in voltage or speed. The other is the thermal limit, as fixed by the heat-storage capacity, the ventilating system, the temperature rise permissible for the type of insulation used, and the desired life expectancy. It is desirable that both of these limits should be indicated in the rating of electrical apparatus for short time, intermittent, or varying duty service.

This report compares the several methods of rating and testing that are now in use and outlines the field for each. It also makes specific recommendations, confirming and extending practices that have been gradually coming into use during recent years. One of these is the use of higher temperature limits for short-time rated than for continuous rated machines. Recognizing the empirical rule that the useful life of organic insulating materials is approximately halved for each 8- to 12-degree centigrade increase in temperature, and that short-time rated apparatus is in operation for only a fraction of the total elapsed time, a limiting temperature rise of 70 degrees centigrade is suggested for 30-minute rated apparatus with Class A insulation; in place of the 50-degree centigrade (by thermometer) value normal for continuous-rated apparatus. Similar increases are suggested for other cases, but the application of these new limits is strictly confined to moderate-sized or small apparatus in which thermal expansion stresses are unimportant, and for short-time service.

The other specific recommendation in the report is the use of the service-factor method of rating, that is especially adapted for intermittent-duty apparatus, such as welding generators. In this method, the nameplate rating indicates the normal or permissible output during periods of sustained high loading, and the rms equivalent over a varying duty cycle, or permissible continuous rating, is indicated by a service factor less than unity applied to the nameplate rating. Under this plan, the only temperature test necessary is a continuous run at the service-factor rating, for which the limiting temperature is normally the same as for continuous-rated apparatus with the same class of insulation.

The report should be read in conjunction with AIEE Standard No. 1, issued in June 1940, which deals with the principles on which temperature limits are based for continuous-rated apparatus.

It is expected that printed copies of this report will be available for distribution prior to the St. Louis meeting. Persons interested should write directly to H. E. Farrer, secretary, AIEE standards committee, 33 West 39th Street, New York, N.Y.

Dielectric Tests Proposed for Outdoor Circuit Interrupters

As a part of the general subject of dielectric tests for electrical equipment currently receiving the active attention of the electrical industry, the AIEE committee on protective devices has recommended to the AIEE standards committee and to other standardizing bodies the use of the values shown in the table as a basis for dielectric tests on outdoor power circuit breakers. At the committee's request these values are submitted here for use and criticism as a preliminary step in the development of a permanent standard.

The impulse values given in the accompanying tabulation are the same as those recommended for outdoor bushings by the AIEE joint committee. The tabulated values now are being considered by other groups of the committee on protective devices for application to other types of apparatus. Wet tests on completed outdoor circuit breakers were omitted because of the complications in making such tests and because the wet tests made on the bushings themselves reasonably serve in lieu of an over-all wet test. The wet tests, however, will be continued on outdoor circuit breaker bushings in line with the recommendation of the joint committee on bushing standardization.

Test Values for Outdoor Power Circuit Breakers of 25,000 Kilovolt-Amperes and Above

Breaker Rating (Kv)	Low-Frequency One-Minute Withstand Test (Kv)	Impulse Test Withstand (Kv)
1.2		
2.5	15	45
5.0	19	60
7.5	26	75
15.0	50	110
23.0	60	150
34.5	80	200
46.0	105	250
69.0	158	350
92.0	209	450
115.0	261	550
138.0	313	650
161.0	365	750
196/230.0	425	900
230.0	485	1,050
287.5	590	1,300
345.0	690	1,550

The AIEE committee on protective devices also has approved the tabulated values for use in AIEE Standard No. 22, "Air Switches and Bus Supports," subject to the qualification that the 23-, 34.5-, and 46-kilovolt classes of this apparatus would not have to meet the new test values until July 1, 1943, because the insulators in these classes do not have to meet the basic insulation levels until January 1, 1943.

Likewise, the tabulated values were adopted for AIEE Standard No. 25, "Fuses—600 Volts and Above," for outdoor fuses rated at 23 kilovolts and up, with the provision that the 23-, 34.5-, and 46-kilovolt air switches would not have to meet the new test values until July 1, 1943. With reference to this apparatus, the committee approved for the 10-second wet test a qualification requiring that completed outdoor fuses of 23 kilovolts and above should withstand twice rated voltage plus one kilovolt.

Personal • • •

Vannevar Bush (A'15, F'24) president, Carnegie Institution of Washington, Washington, D. C., has been named director of the newly-created Office of Scientific Research and Development of the Office of Emergency Management, Washington, D. C. Doctor Bush was born March 11, 1890, in Everett, Mass., and received the degrees of bachelor of science and master of science in electrical engineering from Tufts College in 1913, and doctor of engineering from Massachusetts Institute of Technology and Harvard University in 1916. In 1913 he entered the test department of the General Electric Company, and in 1914 served in the inspection department of the United States Navy. During 1914–15 he was an instructor in mathematics at Tufts College, Medford, Mass., and after doing graduate study at MIT he became assistant professor of electrical engineering at Tufts College. During 1917–18 he was engaged in research on submarine detection in connection with the United States Navy special board on submarine devices. From 1917 to 1922 he was consulting engineer for American Radio and Research Corporation, and was also associate professor of electric power transmission in the department of electrical engineering, Massachusetts Institute of Technology, Cambridge, Mass., from 1919 to 1923 when he was made professor of electric power transmission. He was made vice-president and dean of the MIT school of engineering in 1932, and became president of the Carnegie Institution of Washington in 1938. He is a past director of the AIEE, and was awarded the AIEE Lamme Medal in 1935. He has been active on many Institute committees, and is also a member of the American Academy of Arts and Sciences, the American Physical Society, the Society for the Promotion of Engineering Education, and the National Academy of Sciences. He is the author of "Operational Circuit Analysis", and joint author of "Principles of Electrical Engineering", and author of many technical articles.

Frank Gill (A'03, F'13) vice-president, International Standard Electric Corporation, London, England, was selected from the telephone industry to be knighted in the King's Birthday awards, June 12, 1941, for his part in the development of the telephone industry and international telephony. He was born October 4, 1866, at Castletown, Isle of Man, and from 1882 to 1890 was affiliated with the United Telephone Company, London, and the Telephone Company of Ireland, Dublin. In 1890 he became chief electrician for the Liverpool district of the National Telephone Company, Ltd., and in 1893 was made manager for the Dublin and South of Ireland districts of the company. He became superintendent for Ireland for the company in 1896, and in 1902 was made engineer-in-chief for the whole company. About 1919 he joined the Western Electric Company, London, as European chief engineer, and about 1922 was appointed to the same position with the International Western Electric Company, London. Around 1925 he became European chief engineer for the International Standard Electric Corporation Inc., London, and about 1927 was made vice-president of the company in addition. He was transferred to the office of vice-president of the International Telephone and Telegraph Corporation, Inc., London, the following year, and became vice-president and director of the International Standard Electric Corporation about 1936. He is a past president of the Institution of Electrical Engineers.

R. H. Barclay (A'14, F'28) since 1936 regional director of the Federal Power Commission, New York, N. Y., has resigned this position with the closing of all regional offices of the Commission and concentration of FPC operations in Washington, D. C. From 1908 to 1911 Mr. Barclay was with the Bell Telephone Company of Missouri, St. Louis, Mo., and the Missouri and Kansas Telephone Company, Kansas City, Mo., as chief draftsman, telephone engineer, and superintendent of buildings and power plants for these companies. In 1912 he became assistant electrical engineer for the Kansas City Terminal Railway Company, Kansas City, Mo., and in 1915 joined the Brooklyn-Manhattan Transit Corporation, Brooklyn, N. Y., as assistant engineer. In 1917 he became chief electrical engineer for The Foundation Company, New York, N. Y. He joined Starrett and Van Vleck, Architects, New York, N. Y., as chief electrical engineer, in 1922, and in 1924 became electrical engineer for the Stone and Webster Engineering Corporation, Boston, Mass. From 1913 to 1934 he was president of the manufacturing establishment McClelland Barclay Art Products, Inc., and in 1934 became affiliated with the Federal Power Commission, Washington, D. C., as Chief of the analysis and reports division of the National Power Survey.

J. V. B. Duer (A'15, F'29) chief electrical engineer, Pennsylvania Railroad Company, Philadelphia, Pa., has been appointed assistant to the vice-president of operation for the company. Mr. Duer was born in Poultney, Vt., April 9, 1882, and received the degree of mechanical engineer from Stevens Institute of Technology in 1903. In 1903 he joined the General Electric Company, Lynn, Mass., as electrical apprentice, and in 1904 was transferred to the Schenectady, N. Y., branch of the company. In 1906 he became affiliated with the Long Island Railroad, and served successively as wireman, electrical inspector, and chief clerk to the trainmaster of electrified lines, until 1910 when he became foreman of motormen for the Pennsylvania Railroad, New York, N. Y. In 1913 he was made assistant engineer in charge of electrical department mechanical engineers, for the Pennsylvania Railroad lines east of Pittsburgh and Erie. He became engineer of this department in 1919, and was made electrical engineer for the entire company in 1920. He was promoted to chief electrical engineer in 1935.

L. W. Abbott (A'11, M'21) general manager of installation, Western Electric Company, New York, N. Y., retired in June 1941. He had been with the Bell System since 1900. He became installation engineer for the New England Telephone and Telegraph Company, Boston, Mass., in 1900. In 1902 he was transferred to the engineering department, and in 1912 was appointed supervisor of equipment and building for the company. After serving with the American Expeditionary Forces as captain and major from 1917 to 1919, he returned to his former position with the New England Telephone and Telegraph Company, and was made division superintendent of plant for the company in 1922. In 1923 he became superintendent of installation for the Western Electric Company, New York, N. Y., later serving in the same capacity for the Chicago branch of the company for a short time. He had been general manager of installation for the company since 1935.

T. F. Peterson (A'25, M'32) director, electrical cable works, American Steel and Wire Company, Worcester, Mass., has been appointed director of electric cable engineering and research of the American Steel and Wire Company at the company's headquarters in Cleveland, O. Mr. Peterson was born December 12, 1902, in Brooklyn, N. Y., and received the degrees of bachelor of science, Cooper Union Institute of Technology, 1923, and electrical engineer, Leland Stanford University, 1924. From 1924 to 1925 he was in charge of cable research for the Brooklyn Edison Co., Brooklyn, N. Y., and from 1925 to 1927 was cable engineer for that company. In 1927 he joined the American Steel and Wire Company, New York, N. Y., as cable engineer, later becoming electrical engineer, and in 1931 was transferred to the Worcester, Mass., works of the company as consulting cable engineer. He was appointed director of the electrical cable works at Worcester in 1937.

L. A. Morphey (A'26) formerly superintendent of stations, Northwestern Electric Company, Portland, Ore., has joined the Pacific Power and Light Company, Kennewick, Wash., as assistant superintendent of power. **J. A. Hooper** (A'21) formerly assistant superintendent of stations, will succeed Mr. Morphey as superintendent. Mr. Morphey received the degree of bachelor of science from Montana State College, and became affiliated with the Northwestern Electric Company in 1922. He was made assistant superintendent of stations for the company about 1927, and superintendent of stations about 1930. Mr. Hooper graduated in electrical engineering from Oregon Agricultural College, and was an instructor in the electrical engineering laboratory there from 1917 to 1920. In 1920 he joined the Northwestern Electric Company, as test man. He has been assistant superintendent of stations since about 1936.

H. A. Maxfield (A'21) formerly assistant professor of electrical engineering, Worcester Polytechnic Institute, Worcester, Mass., has been made professor of electrical engineering there. Professor Maxfield was born September 24, 1893, in Lowell, Mass., and received the degree of bachelor of science in electrical engineering from Worcester Polytechnic Institute. From 1916 to 1917 he was employed in the research department of the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, Pa., and for the company at Worcester Polytechnic Institute. From 1917 to 1920 he served as a captain in the heavy artillery of the United States Army, and in 1920 returned to Westinghouse as research engineer. The following year he went to Worcester Polytechnic Institute to do research work in the electrical engineering laboratory there, and in 1922 was made instructor in electrical engineering. He has been assistant professor since about 1927.

S. M. Sharp (A'26) formerly electrical engineer for the Shreveport, La., division of the Southwestern Gas and Electric Company, has been made chief engineer for the company. Born October 14, 1901, in Alma, Ark., Mr. Sharp received the degree of bachelor of electrical engineering from the University of Arkansas in 1924. After a year in the graduate student test course of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., he became assistant engineer for the East St. Louis and Suburban Railway Company, East St. Louis, Ill., in 1924. He joined the Minnesota Power and Light Company, Duluth, Minn., in 1926, as assistant engineer, and about 1927 became electrical engineer for the Central and Southwest Utilities Company, Dallas, Tex. He has been electrical engineer for the Southwestern Gas and Electric Company since about 1932.

D. M. Simmons (A'22, F'28) vice-president, General Cable Corporation, New York, N. Y., has been appointed a member of a liaison committee set up by the Office of Production Management as a co-ordinating link between the electrical industry and the government defense activities. Also serving on the committee are: **C. L. Collens** (A'07, M'40) president, Reliance Electric and Engineering Company, Cleveland, Ohio; **R. W. McChesney** (A'20, M'28) executive vice-president, Harry Alexander, Inc., Washington, D. C., representing National Electrical Contractors Association; **J. W. McNair** (A'25) electrical engineer, American Standards Association, New York, N. Y.; **J. M. Newton** (A'18, F'37) president, Oakes Electric Supply Company, Holyoke, Mass.; and **E. O. Shreve** (A'06) vice-president, General Electric Company, Schenectady, N. Y.

G. R. Benjamin (A'07) has recently retired as engineer of automatics for the Western Union Telegraph Company, New York, N. Y. He had been with the company for 52 years. Mr. Benjamin was born November 25, 1873, in Hartford, Conn. He entered the service of Western Union, New York, in 1888, working as messenger, operator, chief operator, and electrician, at various times. In 1903 he was transferred to the engineering department, to do developmental work, and became automatics engineer in 1912. He was instrumental in developing the Barclay Printing Telegraph System, the Western Union Multiplex System, and numerous other inventions in the field of telegraphic operation and transmission.

W. A. Dudley (M'27) assistant engineer of automatics, engineering department, Western Union Telegraph Company, New York, N. Y., has been appointed engineer of automatics, to succeed G. R. Benjamin, retired. Mr. Dudley was born November 28, 1895, at Colebrook, N. H., and received the degrees of bachelor of science in electrical engineering, 1917, and electrical engineer, 1925, from the University of New Hampshire. He has been with the Western Union Telegraph Company in Boston, Mass., and New York, N. Y., since 1917, except for a period during the first world war when he served as a second lieutenant in the United States Air Service. He was made assistant engineer of automatics in 1920.

C. R. Horrell (A'16, M'25) general sales manager, Sangamo Electric Company, Springfield, Ill., has been elected vice-president and general sales manager of the company. Mr. Horrell was born December 15, 1889, in Stockville, Nebr., and received the degree of bachelor of science in electrical engineering from the University of Illinois in 1913. In 1913 he joined the engineering staff of the engineering sales department of the Electric Appliance Company, Chicago, Ill., and from 1916 to 1918 acted as meter specialist for the company. He became assistant sales manager of the Sangamo Electric Company in 1918, and was made general sales manager in 1922.

Dean Harvey (A'04, M'13) materials engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been elected vice-president of the American Society for Testing Materials. Mr. Harvey was born January 2, 1879, in Chicago, Ill., and received the degree of electrical engineer from Armour Institute of Technology in 1905. From 1900 to 1904 he was an engineer in the electrical department of the Underwriters' Laboratories, Chicago, Ill., taking charge of the department in 1902. In 1904 he became electrical engineer for the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and in 1911 was made materials engineer.

A. D. Hinckley (A'27, M'38) assistant to the dean, Columbia University School of Engineering, New York, N. Y., has been elected general secretary of the Illuminating Engineering Society for 1941–42. **O. P. Cleaver** (A'36) head of the illumination section of the commercial engineering department, Westinghouse Lamp Division, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., has been elected regional vice-president for the northeastern region of the society. **F. A. Hansen** (M'31) managing director, the Western Institute of Light and Vision, Los Angeles, Calif., has been elected regional vice-president for the Pacific Coast region.

C. F. Bowman (A'24, M'30) formerly chief engineer, Montana Railroad and Public Service Commission, Helena, Mont., has become senior assistant utilities engineer with the Maryland Railroad and Public Utility Commission. Mr. Bowman was an instructor in electrical engineering at Purdue University, Lafayette, Ind., from 1923 to 1929, and in 1929 became assistant professor of electrical engineering at Montana State College, Bozeman, Mont. He had been chief engineer for the Montana Railroad and Public Service Commission since 1939. He was chairman of the AIEE Montana Section from 1939 to 1941.

F. W. Brockhoff (A'38) formerly general foreman of the substation division, Union Electric Company of Missouri, St. Louis, Mo., has been appointed to the newly-created position of safety engineer for the company.

E. C. Stone (M'19, F'31) vice-president and general manager of the Duquesne Light Company, Pittsburgh, Pa., has been appointed chairman of the Pittsburgh Defense Council to work under the National Civilian Defense Council.

R. D. Yoder (A'40) sales department, Cutler-Hammer, Inc., Milwaukee, Wis., has been transferred from the Milwaukee headquarters of the company to the Cincinnati office.

K. T. Compton (F'31) president of the Massachusetts Institute of Technology, Cambridge, Mass., has been elected to membership on the advisory council of the National Broadcasting Company.

J. H. Foote (A'18, F'32) supervising engineer, Commonwealth and Southern Corporation, Jackson, Mich., has been elected director-at-large of the Michigan Engineering Society for 1941–42.

Obituary • • •

Bancroft Gherardi (A'95, M'04, F'12) retired vice-president and chief engineer of the American Telephone and Telegraph Company, New York, N. Y., and a past president of the Institute, died August 14, 1941. Doctor Gherardi was born April 6, 1873, in San Francisco, Calif., and received the degrees of bachelor of science, 1891, from the Polytechnic Institute of Brooklyn, mechanical engineer, 1893, and master of mechanical engineering, 1894, from Cornell University, and honorary degrees of doctor of engineering from the Polytechnic Institute of Brooklyn, 1933, and from Worcester Polytechnic Institute, 1936. In 1895 he joined the Metropolitan Telephone and Telegraph Company (later the New York Telephone and Telegraph Company) New York, N. Y., as an assistant engineer, and from 1900 to 1901 was engineer of the traffic department of the company. He was transferred to the position of chief engineer for the New York and New Jersey Telephone Company in 1901, and in 1906 returned to New York as assistant chief engineer for the New York Telephone and Telegraph Company and the New Jersey Telephone Company. In 1907 he was made engineer of plant of the American Telephone and Telegraph Company, New York, N. Y. He became acting chief engineer in 1918, and was appointed chief engineer in 1919. In 1920 he was made vice-president and chief engineer for the company, a position which he held until his retirement in 1938. Doctor Gherardi had been active in the affairs of the Institute, having served as a manager, 1905–08 and 1914–17; vice-president, 1908–10; and president, 1927–28; as a member of several committees and chairman of the committee on Institute policy from 1930 to 1933. He had served as a member of the board of directors of the American Standards Association, United Engineering Societies, and United Engineering Societies Library Board; and had represented the Institute on the National Research Council, United States National Committee of the International Electrotechnical Commission, John Fritz Medal board of award, and the Charles A. Coffin Fellowship and Research Fund Committee. Doctor Gherardi received the Edison Medal in 1932. In 1923 the Japanese Government conferred on him the emblem of the Fourth Order of the Rising Sun. He was also a member of the National Academy of Sciences and the Franklin Institute. He had contributed many articles to technical publications.

Edward Jones Willis (A'97, M'00, F'13) consulting engineer, Richmond, Va., died July 11, 1941. Mr. Willis was born April 1, 1866, in Savannah, Ga., and graduated in mechanical engineering from Stevens Institute in 1888. From 1889 to 1890 he was assistant chemist in the Virginia State Agricultural Department, Richmond, Va., and in 1892 he became an engineer for the Richmond Mica Company. In 1893 he became a draftsman for the Talbot Machine Works, and in 1894 was made general manager of the company. In 1896 he joined the Richmond Traction Company as engineer, becoming superintendent of operation in 1897. From 1898 to 1900 he was steam and electrical engineer for the James River Construction Company, Richmond, Va., and in 1900 became president of the Richmond Electric Works. From 1900 to 1915 he was proprietor of the works, and subsequently went into private practice. During 1917–19 he was associated with the United States Fuel Administration, serving as administrative engineer and director of conservation in Virginia, and from 1919 to 1921 he was chairman of the governor's board of mechanical survey. He was the owner of several patents in the fields of astronomy and navigation, and was the author of "The Methods of Modern Navigation" and other books and monographs. He was also a member of The American Society of Mechanical Engineers, the American Mathematical Society, and the American Association for the Advancement of Science.

John Martin Schreiber (A'03) general manager in charge of plant, Public Service Transportation Company, Newark, N. J., died July 18, 1941. He was born in Ironton, Ohio, September 16, 1876, and received a degree in electrical engineering from Ohio State University in 1899. He joined the Cleveland Electric and Railway Company, Cleveland, Ohio, in 1899, and was made engineer in charge of drafting rooms in 1901. In 1903 he joined the Public Service Corporation of New Jersey as assistant engineer of street railway operations, and became engineer of new shops and was also put in charge of the drafting room of the mechanical department, in 1904. He subsequently was made engineer of maintenance of way, and in 1917 became chief engineer in charge of maintenance of way. He had been general manager in charge of plant since 1927. Mr. Schreiber had made several trips to traffic centers of England, France, and Germany to study transportation problems and engineering developments in those countries. He was a past president of the American Transit Engineering Association, and had been chairman of the special consulting and development committee of the National Association of Motor Bus Operators since 1933. He was also a member of the American Railway Engineering Association, the Society of Automotive Engineers, and the American Society of Civil Engineers.

Alfred Victor Guillou (M'27) consulting engineer, department of water and power, City of Los Angeles, Calif., died in December 1940 according to information just received at Institute headquarters. Born at Ventura, Calif., July 29, 1889, he graduated in electrical engineering from the University of California in 1912. From 1912 to 1914 he served an apprenticeship in the ship and test departments of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. In 1914 he became sales engineer for the Pacific Light and Power Corporation, Los Angeles, Calif., and in 1916 was made district agent for its successor, the Mt. Whitney Power and Electric Company, Porterville, Calif. In 1919 he was transferred to the engineering department of the Southern California Edison Company, Los Angeles, Calif. (also a successor to the Pacific Light and Power Corporation). He became assistant engineer for the gas and electric division of the California Railroad Commission in 1920, and was appointed gas and electric engineer for the Commission in 1923. He became assistant chief engineer of the Commission in 1926. From 1931 to 1933 he was chief engineer for the Public Service Commission of Wisconsin, and had been engineer for the City of Los Angeles department of water and power since 1933.

Charles Ernest Canfield (A'02, M'34) retired mechanical engineer, the General Electric Company, Pittsfield, Mass., died July 12, 1941. He was born October 13, 1870, at Arlington, Vt., and received the degree of bachelor of science in electrical engineering from the University of Vermont in 1898. From 1888 to 1890 he was assistant to a patent attorney at Bennington, Vt., and from 1890 to 1895 he was employed as mechanical draftsman with the Gilbert Car Manufacturing Company, Troy, N. Y., Brown and Sharpe Company, Providence, R. I., the Lamokin Car Company, Chester, Pa., and William Sellers and Company, Philadelphia, Pa. In 1899 he became assistant engineer of design of a-c generators for the Stanley Electric Company, Pittsfield, Mass., and in 1904 joined the Western Electric Company, Chicago, Ill., as engineer in charge of a-c generator design. He became chief engineer for the Warren Electric Company, Sandusky, Ohio, in 1908, and in 1909 went to Petersborough, Ont., Canada, as engineer in charge of a-c generator design for the Canadian General Electric Company. He joined the General Electric Company, Pittsfield, Mass., as mechanical engineer, in 1919. He retired from this position in 1941.

Henry T. Purdy (A'13, M'27) president, H. T. Purdy, Inc., San Jose, Costa Rica, Central America, died January 31, 1940. Mr. Purdy was born in Brooklyn, N. Y., February 22, 1866. From 1879 to 1895 he served as apprentice machinist, journeyman machinist, and construction engineer for various electric companies. In 1895 he became superintendent and engineer for the Georgetown and Tenallytown Railway, and Potomac Light and Power Company, Washington, D. C., and in 1898 became construction engineer for the Costa Rica Electric Light and Traction Company, San Jose, Costa Rica. He later was made manager for the company. In 1905 he became staff engineer for the Abangarez Gold Fields and Boston and Central America Mines and Development Company, Costa Rica, later becoming assistant to the manager and then acting manager for Costa Rica. In 1908 he formed the Purdy Engineering Company (later H. T. Purdy, Inc.), engaging in consulting, constructing, and contracting business and representing American machinery manufacturers in Central America. He served as president of the company until the time of his death.

Friedrick Eichberg (F'28) consulting research engineer for the Stinson division of the Vultee Aircraft Corporation's Wayne, Mich., plant, died July 30, 1941. Born in Vienna, Austria, September 10, 1875, Doctor Eichberg graduated from the Technische Hochschule Wien, and was an assistant professor there from 1896 to 1899. In 1899 he became affiliated with the A.E.G.-Union Electric and Manufacturing Company of Austria and Germany, as consulting engineer and manager of the railway department. He was made manager of the company in 1921 and a member of the board of directors of the A.E.G., Berlin, in 1926. At the same time he was general manager of the Linke-Hoffman car and locomotive factory at Breslau, Germany. He came to America in 1938. He was the owner of several patents, among them one for the Winter-Eichberg single-phase railway motor. He was the recipient of a special doctorate from the Technische Hochschule in Breslau, and was a former director of the Bavarian Technological Museum at Munich.

LeRoy Ormand Ripley (A'05) retired president of the Kansas Gas and Electric Company, Wichita, Kansas, died July 22, 1941. Born April 20, 1877, at Laurens, N. Y., he graduated in electrical engineering from Union College in 1900. After working for a short time on electrical installation and construction in Cooperstown, N. Y., he took charge of construction of a municipal power plant in Marathon, N. Y., in 1902, and was also in charge of operation of the plant for a short time He became superintendent of the light and power department of the Schenectady Railway Company, Schenectady, N. Y., in 1903, and in 1905 when the illuminating functions of the company were made a separate branch he was made manager of the Schenectady Illuminating Company. In 1909 he became vice-president of the newly-organized Kansas Gas and Electric Company, and was made president about 1931. He retired as president of the company in June 1940, but continued to serve in a consulting capacity. He received an honorary degree from Union College in 1940.

John P. Otis (A'27) chief of mechanical section, construction division, United States Indian Service, Washington, D. C., died February 17, 1941. Born January 3, 1904, in Baltimore, Maryland, Mr. Otis received the degree of bachelor of engineering in electrical engineering from Johns Hopkins University. From 1922 to 1924 he was with the General Electric Company, Baltimore, Md., as tester and later as switchboard assembler. After a short time as tester for the Locke Insulator Corporation, Baltimore, he again joined the General Electric

Company, Baltimore, in 1925, as a designer. About 1927 he became an instructor in the Boys' Vocational School, Baltimore, and the following year he became associated with the firm of Lowekamp and Otis, as electrical contractor. About 1930 he was made assistant electrical engineer in the bureau of yards and docks, Navy Department, Washington, D. C., and later transferred to the Bureau of Indian Affairs, Department of the Interior, Washington, D. C., as superintendent of construction. He was made chief of the mechanical section about 1939.

Frederick W. Hehre (A'13, M'15, F'29) head of the department of electrical engineering, Columbia University, New York, N. Y., died July 27, 1941. Born November 1, 1886, in New York, N. Y., Professor Hehre received the degree of electrical engineer from Columbia University in 1908. After a year as an inspector for the New York Edison Company, New York, N. Y., he became an instructor in electrical engineering at Columbia University in 1909. He was made assistant professor of electrical engineering in 1916. From 1917 to 1919 he was a lieutenant in the United States Naval Reserve Force, serving as electrical officer and engineer officer. He returned to Columbia University and in 1924 was made associate professor of electrical engineering. He became full professor in 1938, and shortly before his death had been appointed to head the department of electrical engineering. He was coauthor of "Electrical Circuits and Machinery" and author of technical articles.

Robert Elmore Lyle (A'32) assistant electrical engineer, system engineering section, engineering division, Bonneville Power Administration, Portland, Ore., died July 20, 1941. Born July 1, 1908, at Pullman, Wash., Mr. Lyle received the degree of bachelor of science in electrical engineering from Washington State College in 1930. He enrolled in the graduate student course of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., in 1930, and later did graduate study at the University of Pittsburgh. In 1935 he became electrical engineer for the Washington State College engineering experiment station, Pullman, Wash., and in 1937 joined the Westinghouse Electric and Manufacturing Company, Seattle, Wash., as engineer. The following year he became electrical engineer for the City of Tacoma department of utilities, Tacoma, Wash., and in 1939 was employed as a junior engineer on the Bonneville Project, Portland, Ore., later becoming assistant electrical engineer.

Edward A. Harley (A'06) retired, formerly supervisor of d-c substations, New York Edison Company, New York, N. Y., died July 9, 1941. He was born July 27, 1870, in Brooklyn, N. Y., and in 1884 joined the Edison Electric Illuminating Company of New York, later New York Edison, one of the predecessors of the Consolidated Edison Company of New York, Inc. After working for some time in the meter, operating, testing, and installation departments, he was made assistant operating superintendent of the first district for the company in 1895. He became assistant operating superintendent of the third district in 1901, and from 1902 to about 1930 was operating superintendent in charge of the third district. He then became supervisor of the bureau of substations for the company, and later supervisor of d-c substations, retiring from that position about 1935.

James Carr Smith (A'20) commercial manager, Charleston division, Appalachian Electric Power Company, Charleston, W. Va., died July 18, 1941. Mr. Smith was born November 29, 1871, at Chilhowie, Smythe County, Va., and received the degree of bachelor of science from Milligan College in 1900. After some time as chief clerk, paymaster, and superintendent of mines and quarries for the Virginia Iron Coal and Coke Company, Bristol, Radford, and Roanoke, Va., he became assistant to the vice-president and general manager of the Virginian Power Company, Charleston, W. Va., in 1914. When the Virginian Power Company was merged with the Appalachian Electric Power Company about 1918, he was made commercial manager and purchasing agent for the Charleston division of the latter. He was also a member of the National Electric Light Association.

Newell M. Porter (A'31) maintenance engineer, Southwestern Bell Telephone Company, Oklahoma City, Oklahoma, died May 29, 1941. Mr. Porter was born February 14, 1895, in Crockett, Texas. From 1914 to 1917 he worked as a repairman, and in 1917 joined the Western Electric Company as installer and tester in the installation department. He was made job foreman for the company in 1924, in charge of supervision of the installation of central office telephone equipment. He became equipment engineer for the Southwestern Bell Telephone Company, in 1929, and later in that year was made maintenance engineer for the company at Oklahoma City.

John Corliss Bennett (A'90, M'13) retired, formerly commercial engineer with the General Electric Company, New York, N. Y., died August 2, 1941. He was 75 years of age. Mr. Bennett joined the General Electric Company in 1898, after 8 years spent in designing various small central stations. From 1898 to 1909 he was in charge of the estimating department at the New York office of the company, and in 1909 he became commercial engineer, a position which he held until his retirement 11 years ago.

Wilfred Joseph Lacerte (A'28) telephone systems development engineer, Bell Telephone Laboratories, Inc., New York, N. Y., died October 12, 1940. Mr. Lacerte was born January 20, 1899 in Granby, Canada, and received the degree of bachelor of science in electrical engineering from the University of Kansas in 1923. He joined the Bell Telephone Laboratories in 1923 as telephone systems development engineer, a position which he held until the time of his death.

Membership • •

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical Districts. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before September 30, 1941, or November 30, 1941 if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Casler, C. L., Central New York Power Corporation, Syracuse, N. Y.
Marriott, E. E., Lone Star Cement Corporation, Hudson, N. Y.
Molloy, J. J., Cambridge Electric Light Company, Cambridge, Mass.
Port, R. F. (Associate re-election), Central New York Power Corporation, Syracuse, N. Y.
Rhea, T. R., General Electric Company, Schenectady, N. Y.

2. Middle Eastern

Feder, J. B. (Member re-election), Department of Commerce, Washington, D. C.
Kamoroff, D., United States War Department, Aberdeen Proving Grounds, Md.
Miller, C. F., Johns Hopkins University, Baltimore, Md.

3. New York City

Beger, A. R. (Associate re-election), Ward Leonard Electric Company, Mount Vernon, N. Y.
Boughtwood, J. E., Western Union Telegraph Company, New York, N. Y.
Miller, H. G., J. G. White Engineering Corporation, New York, N. Y.
Reynolds, H. B. (Member), New York City Transit System, New York, N. Y.
Smith, R. D. (Member), Merck and Company, Incorporated, Rahway, N. J.

4. Southern

Banning, F. D. (Member), Florida Power and Light Company, Miami.
Edmonds, J. R., Freeport Sulphur Company, Port Sulphur, La.
Ely, R. B., U. S. Engineer Office, Charleston, S. C.

5. Great Lakes

Hubbard, E. L., General Electric Company, Detroit, Mich.
Ikerd, H. M., Iowa State College, Ames.
Koetsier, A. J., Westinghouse Electric and Manufacturing Company, Detroit, Mich.
Lorimer, J. L., David Bradley Manufacturing Company, Bradley, Ill.
Messer, G. E., General Electric Company, Detroit, Mich.
Ogden, W. F. (Member), Edison General Electric Appliance Company, Inc., Chicago, Ill.

7. South West

Gower, S. G., United States Government, Duncan Field, South San Antonio, Tex.
Parker, T. E., 200th Coast Artillery (AA) AATC, Fort Bliss, Tex.

8. Pacific

Chambers, W. W., Navy Department, Bureau of Ordnance, Long Beach, Calif.
Davis, J. H. (Member), Department of Water and Power, Los Angeles, Calif.
Hart, L., Associated Telephone Company, Ltd., Santa Monica, Calif.
Keene, K. W., 115 San Rafael Avenue, San Rafael, Calif.
Purdon, A. (Associate re-election), Crocker-Wheeler Electric Manufacturing Company, San Francisco, Calif.
White, G. A., United States Army, Quartermaster Corps, Fort Huachuca, Ariz.
Wood, L. M., Douglas Aircraft Company, Santa Monica, Calif.

9. North West

Jerviss, J. R., Westinghouse Electric and Manufacturing Company, Seattle, Wash.
Palo, G. M. (Member), Siems Drake Puget Sound, Seattle, Wash.

10. Canada

Laverock, D. J., Columbia Power Company, Limited, Vancouver, B. C.
Mable, W. H., H. G. Acres and Company, Niagara Falls, Ont.

Total, United States and Canada, 35

Elsewhere

Hatfield, S. A., Royal Air Force Station, Kalrit, Egypt.
Kumar, C. R., The Indian Scientific Services Registered, Tuni, India.

Total, elsewhere, 2

Officers and Committees for 1941-42

Officers

President

DAVID C. PRINCE Schenectady, N. Y.
(Term expires July 31, 1942)

Junior Past Presidents

F. MALCOLM FARMER New York, N. Y.
(Term expires July 31, 1942)

R. W. SORENSEN Pasadena, Calif.
(Term expires July 31, 1943)

Vice-Presidents

District

1 EVERETT S. LEE Schenectady, N. Y.
3 J. W. BARKER New York, N. Y.
5 K. L. HANSEN Milwaukee, Wis.
7 J. L. HAMILTON St. Louis, Mo.
9 A. LeROY TAYLOR Salt Lake City, Utah
(Terms expire July 31, 1942)

2 N. S. HIBSHMAN Bethlehem, Pa.
4 J. ELMER HOUSLEY Alcoa, Tenn.
6 ARTHUR L. JONES Denver, Colo.
8 WALTER C. SMITH San Francisco, Calif.
10 C. A. PRICE Hamilton, Ont.
(Terms expire July 31, 1943)

Directors

L. R. MAPES Chicago, Ill.
W. B. MORTON Philadelphia, Pa.
H. S. OSBORNE New York, N. Y.
(Terms expire July 31, 1942)

MARK ELDREDGE Washington, D. C.
R. E. HELLMUND East Pittsburgh, Pa.
F. J. MEYER Oklahoma City, Okla.
(Terms expire July 31, 1943)

T. F. BARTON New York, N. Y.
M. S. COOVER Ames, Iowa
R. G. WARNER New Haven, Conn.
(Terms expire July 31, 1944)

L. R. GAMBLE Spokane, Wash.
T. G. LeCLAIR Chicago, Ill.
FRED R. MAXWELL, JR. Pensacola, Fla.
(Terms expire July 31, 1945)

National Treasurer

W. I. SLICHTER New York, N. Y.
(Term expires July 31, 1942)

National Secretary

H. H. HENLINE New York, N. Y.
(Term expires July 31, 1942)

General Counsel

Parker & Aaron
20 Exchange Place, New York, N. Y.

Local Honorary Secretaries

Australia—V. J. F. Brain, Department of Works and Local Government, Bridge St., Sydney, N.S.W.

Brazil, S. A.—Richard H. Bowles, São Paulo Tramway Light and Power Co., São Paulo.

England—A. P. M. Fleming, Metropolitan Vickers Electric Co., Trafford Park, Manchester.

France—A. S. Garfield, 173 Boulevard Haussmann, Paris, 8E.

India, Northern—V. F. Critchley, 3 Abbot Road, Lahore, Punjab.

India, Southern—N. N. Iengar, Tata Power Co. Ltd., Bombay House, Bruce St., Fort Bombay.

New Zealand—P. H. Powell, Canterbury College, Christchurch.

Sweden—A. F. Enstrom, Ingeniorsvetenskrapsakademien, Stockholm, 5.

Transvaal, Africa—W. Elsdon-Dew, P. O. Box 4563, Johannesburg.

General Committees

Executive

David C. Prince, *chairman*, 1 River Road, Schenectady, N. Y.

T. F. Barton
F. Malcolm Farmer
R. E. Hellmund
H. S. Osborne
W. I. Slichter
R. W. Sorensen

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A. E. Knowlton, *chairman*, *Electrical World*, 330 W. 42d St., New York, N. Y.

H. E. Farrer, *secretary*, AIEE, 33 W. 39th St., New York, N. Y.

P. H. Adams
T. F. Barton
Robin Beach
L. T. Blaisdell
L. W. Chubb
F. E. D'Humy
E. D. Doyle
J. F. Fairman
Harold Goodwin, Jr.
L. F. Hickernell
Alexander Maxwell
L. W. W. Morrow
A. G. Oehler
H. S. Warren
R. J. Wiseman

Code of Principles of Professional Conduct

Dugald C. Jackson, *chairman*, 5 Mercer Circle, Cambridge, Mass.

H. V. Carpenter
F. B. Jewett
W. M. Piatt
Walter C. Smith
C. E. Stephens

Constitution and Bylaws

I. Melville Stein, *chairman*, Leeds and Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

Mark Eldredge
Everett S. Lee
C. A. Powel
W. I. Slichter

Edison Medal

Appointed by the president for term of five years

C. R. Jones Everett S. Lee H. S. Osborne
(Terms expire July 31, 1942)

J. W. Barker W. H. Harrison
N. E. Funk, *chairman*
(Terms expire July 31, 1943)

W. B. Kouwenhoven F. V. Magalhaes
L. W. W. Morrow
(Terms expire July 31, 1944)

K. T. Compton W. D. Coolidge J. M. Thomson
(Terms expire July 31, 1945)

J. T. Barron R. E. Doherty J. V. B. Duer
(Terms expire July 31, 1946)

Elected by the board of directors from its own membership for term of two years

T. F. Barton R. E. Hellmund D. C. Prince
(Terms expire July 31, 1942)

M. S. Coover M. Eldredge R. W. Sorensen
(Terms expire July 31, 1943)

Ex officio

David C. Prince, president
W. I. Slichter, national treasurer
H. H. Henline, national secretary
(Terms expire July 31, 1942)

Finance

H. S. Osborne, *chairman*, 195 Broadway, New York, N. Y.

T. F. Barton
F. Malcolm Farmer

Charles LeGeyt Fortescue Fellowship

O. E. Buckley, *chairman* Everett S. Lee
(Terms expire July 31, 1942)

C. A. Powel D. C. Prince
(Terms expire July 31, 1943)

W. F. Davidson D. F. Miner
(Terms expire July 31, 1944)

Headquarters

Edward C. M. Stahl, *chairman*, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

H. H. Henline
H. S. Osborne

Institute Policy

C. R. Beardsley, *chairman*, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

F. C. Bolton
L. W. Chubb
H. B. Gear
W. B. Kouwenhoven
R. C. Muir
H. S. Osborne
C. A. Price
W. H. Timbie

Lamme Medal

F. F. Brand Howard Maxwell C. A. Powel
(Terms expire July 31, 1942)

Mark Eldredge M. J. Kelly
R. E. Hellmund, *chairman*
(Terms expire July 31, 1943)

R. N. Conwell I. Melville Stein S. B. Williams
(Terms expire July 31, 1944)

Membership

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J. H. Pilkington, *vice-chairman*, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

L. F. Howard, *secretary*, 195 Broadway, Room 1739, New York, N. Y.

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W. J. Lyman (2)
W. S. Hill (3)
J. G. Tarboux (4)
L. T. Rosenberg (5)
Murray G. Graff (6)
L. O. Campbell (7)
Harry Caldwell (8)
C. H. Cutter (9)
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Members-at-large

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J. M. Dodds
Stanton Hertz
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F. H. Lane
F. J. Meyer
W. B. Morton
Roy L. Webb
M. B. Wyman

Ex officio

Chairmen of membership committees of all Sections

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P. L. Alger
M. S. Coover
F. Malcolm Farmer
H. B. Gear
H. H. Henline
R. T. Henry
R. C. Muir
H. S. Osborne
H. S. Phelps
I. Melville Stein

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P. L. Alger, *chairman*, General Electric Co., Schenectady, N. Y.

J. W. Barker H. S. Phelps R. W. Sorensen

Publication

Howard S. Phelps, *chairman*, Philadelphia Electric Co., 2301 Market St., Philadelphia, Pa.

F. A. Lewis, *secretary*, AIEE, 33 W. 39th St., New York, N. Y.

J. W. Barker
F. Malcolm Farmer
H. H. Henline
John Mills
A. G. Oehler
F. H. Pumphrey
H. H. Race
S. P. Shackleton
D. M. Simmons
I. Melville Stein
S. B. Williams

Research

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F. M. Clark
M. J. Kelly
Everett S. Lee
W. A. Lewis, Jr.
K. W. Miller
E. L. Moreland
G. W. Penney
F. B. Silsbee
Joseph Slepian
E. C. Starr
C. G. Suits
V. K. Zworykin

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W. C. Wagner, *vice-chairman*, Bureau of Ships, 3349 Navy Bldg., Washington, D. C.

W. B. Kouwenhoven, *secretary*, Johns Hopkins University, Baltimore, Md.

L. F. Adams
George S. Diehl
Mark Eldredge
John B. Fisken
L. E. A. Kelso
Wills Maclachlan
F. V. Magalhaes
G. C. A. Opp
C. N. Rakestraw
E. C. Rue
W. R. Smith
H. H. Weber

Sections

M. S. Coover, *chairman*, Iowa State College, Ames, Iowa

W. B. Morton, *vice-chairman and secretary*, 900 Sansom St., Philadelphia, Pa.

C. A. Faust
O. W. Holden
S. J. Lisberger
E. T. Mahood
R. M. Pfalzgraff
H. H. Race
J. M. Thomson

Ex officio

Chairmen of all Institute Sections

Standards

R. T. Henry, *chairman*, 303 Electric Building, Buffalo, N. Y.

P. L. Alger, *vice-chairman*, General Electric Co., Schenectady, N. Y.

H. E. Farrer, *secretary*, AIEE, 33 W. 39th St., New York, N. Y.

P. L. Alger
Edward Bennett
E. C. Crittenden
W. P. Dobson
R. E. Hellmund
A. H. Kehoe
Alexander Maxwell
A. C. Monteith
S. H. Mortensen
E. B. Paxton
Gordon Thompson
R. L. Young

Ex officio

Chairmen of working and co-ordinating committees
Chairmen of AIEE technical committees
Chairmen of AIEE delegations on other standardizing bodies or sole representative thereon
President and honorary president, United States National Committee of the International Electrotechnical Commission

Student Branches

H. W. Bibber, *chairman*, Ohio State University, Columbus, Ohio

W. J. Miller
Albrecht Naeter
B. L. Robertson
Charles F. Scott
G. H. Sechrist
E. M. Strong
G. W. Swenson
R. G. Warner

Ex officio

Student Branch counselors

Technical Program

P. L. Alger, *chairman*, General Electric Co., Schenectady, N. Y.

J. F. Fairman, *vice-chairman*, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

C. S. Rich, *secretary*, AIEE, 33 W. 39th St., New York, N. Y.

J. W. Barker
H. W. Bibber
F. A. Cowan
W. B. Morton
H. S. Phelps
T. A. Worcester

Ex officio

L. R. Mapes, chairman, committee on planning and co-ordination
Frank Thornton, Jr., chairman, committee on safety
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Arizona	8	Mar. 22, '41	28	Ben Ferguson	W. H. Croft	Central Arizona Light and Power Co., Phoenix, Ariz.
Boston	1	Feb. 13, '03	439	J. M. Murray	W. I. Middleton	Simplex Wire and Cable Co., Cambridge, Mass.
Central Indiana	5	Jan. 12, '12	144	L. J. Dunnewold	J. R. Pies	R.C.A. Mfg. Co., Inc., Indianapolis, Ind.
Chicago	5	1893	810	K. V. Glentzer	J. C. Woods	Commonwealth Edison Co., Chicago, Ill.
Cincinnati	2	June 30, '20	212	E. F. Nuezel	S. M. Hamill, Jr.	323 Plum St., Cincinnati, Ohio
Cleveland	2	Sept. 27, '07	363	D. E. Moat	S. R. Orem	Westinghouse Electric and Mfg. Co., Cleveland, Ohio
Columbus	2	Mar. 17, '22	86	D. E. Stafford	S. A. Martin	215 No. Front St., Columbus, Ohio
Connecticut	1	Apr. 16, '21	299	H. W. Sundius	A. G. Conrad	Yale University, New Haven, Conn.
Denver	6	May 18, '15	177	L. M. Robertson	Hubert Sharp	Mountain States Tel. and Tel. Co., Box 960, Denver, Colo.
East Tennessee	4	Sept. 2, '36	137	F. J. Stevens	J. H. Christensen	TVA, Power Bldg., Chattanooga, Tenn.
Erie	2	Jan. 11, '18	56	H. G. Moore	W. D. Bearce	4121 Sassafras St., Erie, Pa.
Florida	4	Jan. 28, '31	100	Stanley Warth	Joseph Weil	University of Florida, Gainesville, Fla.
Fort Wayne	5	Aug. 14, '08	80	G. C. Harvey	R. W. Clark	Magnavox Co., Fort Wayne, Ind.
Georgia	4	Jan. 14, '04	122	E. W. O'Brien	R. L. Williamson	Aluminum Co. of America, Atlanta, Ga.
Houston	7	Aug. 7, '28	141	N. F. Rode	H. P. Heafer	2023 South Blvd., Houston, Texas
Iowa	5	June 25, '29	81	K. R. Brown	L. A. Ware	University of Iowa, Iowa City, Iowa
Ithaca	1	Oct. 15, '02	55	J. P. Wood	H. G. Smith	Cornell University, Ithaca, N. Y.
Kansas City	7	Apr. 14, '16	128	A. T. Campbell	M. E. Bretschneider	Kansas City Power and Light Co., Kansas City, Mo.
Lehigh Valley	2	Apr. 16, '21	194	J. W. Mills	L. Z. Ludorf	119 No. Atherton Ave., Kingston, Pa.
Los Angeles	8	May 19, '08	507	F. C. Lindvall	L. F. Hunt	Box 351, Los Angeles, Calif.
Louisville	4	Oct. 15, '26	86	J. R. Smith	T. J. Borgman	Southern Bell Tel. and Tel. Co., Louisville, Ky.
Lynn	1	Aug. 22, '11	167	J. W. Lingary	W. R. Cox	General Electric Co., 920 Western Ave., Lynn, Mass.
Madison	5	Jan. 8, '09	72	R. R. Knoff		
Mansfield	2	Mar. 6, '39	77	C. P. Robinson	Wm. C. Bruckman	374 Sturges Ave., Mansfield, Ohio
Maryland	2	Dec. 16, '04	286	G. R. Page	M. W. Pullen	Johns Hopkins University, Baltimore, Md.
Memphis	4	May 23, '30	66	C. L. Osenbaugh	W. J. Fransioli, Jr.	Memphis Light, Gas and Water Div., Memphis, Tenn.
Mexico	3	June 29, '22	57	C. Santacruz	C. C. Jagou	Apartado 2966, Mexico City, Mexico
Michigan	5	Jan. 13, '11	398	S. M. Dean	M. B. Stout	University of Michigan, Room 274, Ann Arbor, Mich.
Milwaukee	5	Feb. 11, '10	286	E. W. Hatz	W. Richter	First Wisconsin National Bank Bldg., Milwaukee, Wis.
Minnesota	5	Apr. 7, '02	103	K. J. Mertz	W. H. Gille	Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Montana	9	June 24, '31	40	E. W. Schilling	Herold Murdock	Montana Power Co., 18 East Main, Bozeman, Mont.
Muscle Shoals	4	Feb. 18, '38	30	M. B. Clayton	E. H. Noedel	Box 1322, Wilson Dam, Ala.
Nebraska	6	Jan. 21, '25	45	D. J. DeBoer	B. E. Ellsworth	1018 South 34th St., Lincoln, Nebr.
New Mexico-West Texas	7	Mar. 7, '40	43	M. A. Thomas	O. F. Metz	Allis-Chalmers Manufacturing Co., El Paso, Tex.
New Orleans	4	Dec. 8, '33	132	B. P. Babin	F. E. Johnson	317 Baronne St., New Orleans, La.
New York	3	Dec. 10, '19	3,492	D. A. Quarles	C. S. Purnell	Westinghouse Elec. and Mfg. Co., 40 Wall St., New York, N. Y.
Niagara Frontier	1	Feb. 10, '25	207	E. B. Alexander	Wm. K. Parks	Westinghouse Elec. and Mfg. Co., Buffalo, N. Y.
North Carolina	4	Mar. 21, '29	101	H. B. Wolf	W. B. White	210 E. Sixth St., Charlotte, N. C.
North Texas	7	May 18, '28	181	G. N. Pingree	T. D. Thomas	Texas Power and Light Co., Dallas, Tex.
Oklahoma City	7	Feb. 16, '22	117	John Wallis	R. L. Jones	Southwestern Bell Tel. Co., Oklahoma City, Okla.
Philadelphia	2	Feb. 18, '03	750	W. B. Morton	A. C. Muir	Berwind-White Coal Mining Co., Philadelphia, Pa.
Pittsburgh	2	Oct. 13, '02	630	R. L. Dunlap	B. M. Jones	Duquesne Light Co., 435—6th Ave., Pittsburgh, Pa.
Pittsfield	1	Mar. 25, '04	197	S. T. Maunder	F. E. Nutt	General Electric Co., Pittsfield, Mass.
Portland	9	May 18, '09	196	J. A. Hooper	D. L. Brown	Portland General Electric Co., Portland, Ore.
Providence	1	Mar. 12, '20	95	W. C. Whitman	R. W. Herrick	General Electric Co., Providence, R. I.
Rochester	1	Oct. 9, '14	110	W. F. Cotter	C. F. Harris	Westinghouse Electric and Mfg. Co., Rochester, N. Y.
St. Louis	7	Jan. 14, '03	304	R. Meyerand	C. W. Schemm	General Electric Co., St. Louis, Mo.
San Diego	8	Jan. 18, '39	46	C. J. Nevitt	W. T. Johnson	Nevada-Calif. Electric Corp., El Centro, Calif.
San Francisco	8	Dec. 23, '04	543	M. S. Barnes	C. E. Baugh	Pacific Gas and Electric Co., San Francisco, Calif.
Saskatchewan	10	Oct. 14, '25	10	M. L. Haynes	J. R. Young	1945 Scarth St., Regina, Sask., Canada
Schenectady	1	Jan. 26, '03	484	D. E. Chambers	T. T. Woodson	General Electric Co., Research Lab., Schenectady, N. Y.
Seattle	9	Jan. 19, '04	202	K. L. Howe	C. S. Alger	Puget Sound Power and Light Co., Seattle, Wash.
Sharon	2	Dec. 11, '25	120	M. L. Manning	J. G. Mitchell	Pennsylvania Power Co., Sharon, Pa.
South Bend	5	Feb. 26, '41	52	D. C. Jackson, Jr.	F. M. Henderson	Indiana and Michigan Electric Co., South Bend, Ind.
South Carolina	4	Mar. 2, '40	50	S. R. Rhodes	N. H. Coit	South Carolina Electric and Gas Co., Columbia, S. C.
South Texas	7	May 23, '30	48	R. W. Warner	G. E. Schmitt	Lower Colorado River Authority, Austin, Tex.
Spokane	9	Feb. 14, '13	84	G. L. Lane	H. E. Mellrud	Washington Water Power Co., Spokane, Wash.
Springfield	1	June 29, '22	51	H. D. Griffith	I. Creaser	76 Cortland St., Springfield, Mass.
Syracuse	1	Aug. 12, '20	103	V. J. Brown	S. C. Osborne	200 Rugby Road, Syracuse, N. Y.
Toledo	2	June 3, '07	80	K. C. Davis	W. M. Campbell	2145 Central Grove Ave., Toledo, Ohio
Toronto	10	Sept. 30, '03	363	O. W. Titus	A. R. Zimmer	University of Toronto, Toronto, Ont., Canada
Tulsa	7	Oct. 1, '37	90	J. V. McGinity	O. A. Hass	Allis-Chalmers Manufacturing Co., Tulsa, Okla.
Urbana	5	Nov. 25, '02	68	L. B. Archer	G. R. Peirce	Univ. of Illinois, 212 Electrical Engineering Lab., Urbana, Ill.
Utah	9	Mar. 9, '17	72	H. H. Krueger	J. A. McDonald	General Electric Co., Salt Lake City, Utah
Vancouver	10	Aug. 22, '11	91	J. A. Tames	F. V. Knight	1796 West 5th Ave., Vancouver, B. C., Canada
Virginia	4	May 19, '22	137	L. Saunders	C. L. Crosby	Richmond Trust Bldg., Richmond, Va.
Washington	2	Apr. 9, '03	491	F. M. Defandorf	F. W. Willcutt	Potomac Electric Power Co., Washington, D. C.
West Virginia	2	Apr. 9, '40	54	H. P. Musser	W. J. Blake	119 Wyoming St., Charleston, W. Va.
Wichita	7	Sept. 16, '37	64	C. V. Waddington	H. E. Margrave	Kansas Gas and Electric Co., Wichita, Kans.
Worcester	1	Feb. 18, '20	65	G. M. L. Sommerman	T. R. Holton	American Steel and Wire Co., Worcester, Mass.
Total	72					

Of Current Interest

National Defense

Four-Year Power Expansion Program Proposed by FPC

"To provide adequate power supply for the Defense program in 1943, 1944, 1945, and 1946," the Federal Power Commission presented to the President in July a program calling for the installation of nearly 13,500,000 kw of new generating capacity over the four-year period. The Commission recommends that a subsidiary of the Reconstruction Finance Corporation be set up to place and finance orders for the necessary generating equipment.

The 13,500,000 kw of new generating capacity is divided roughly into 8,600,000 kw for steam, chiefly for private companies, and 4,900,000 kw for hydroelectric power, mostly government-owned, 900,000 kw of which is assigned to the St. Lawrence Seaway project. Presented with the report was a tentative list of projects, a summary of which appears in the accompanying tabulation.

Orders for generating equipment sufficient to keep manufacturers operating at full capacity for the next five years should be prepared at once and financial commitments made for units to be completed in 1943 or 1944, the Commission states. Such orders are to be based on the Commission's program for location of new capacity, subject to modification by the Office of Production Management. Funds advanced for this purpose by the RFC are expected to average between $150,000,000 and $200,000,000 a year. Both publicly and privately owned utilities will be given opportunity to undertake the commitment either directly or on a lease-purchase basis of units provided for their systems. The Commission is expected to work out modifications of the plan in conference with representatives of individual utilities.

Expenditures averaging about $170,000,000 annually are expected to be made by the United States Corps of Engineers, the Bureau of Reclamation, the Tennessee Valley Authority, and other agencies, for the construction of dams, reservoirs, and powerhouses for the hydroelectric projects, exclusive of the cost of generating equipment. The cost of steam-electric projects, also exclusive of equipment, is expected to average between $75,000,000 and $100,000,000 a year, and "may be expected to come largely from private sources."

Summary of FPC Program for New Generating Facilities 1943–46

Region	States	Steam Electric No. Systems	Steam Electric No. Plants	Steam Electric Kw	Hydroelectric No. Plants	Hydroelectric Kw	Gross Total Kw
I	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, eastern Pennsylvania, New Jersey, Delaware, most of Maryland, and the District of Columbia	19	25	2,500,000	11	1,222,000	3,722,000
II	Western Pennsylvania, northwestern Maryland, West Virginia, Ohio, Michigan, major parts of Indiana, Kentucky, and southwestern Virginia	16	26	2,300,000	15	573,000	2,873,000
III	Eastern and northern Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Tennessee, and eastern Mississippi	11	18	1,075,000	12	1,129,000	2,204,000
IV	Wisconsin, Illinois, Iowa, northeastern Missouri, most of Minnesota, small parts of northeastern Nebraska, eastern South Dakota, and northern Indiana	13	21	1,805,000	1	15,000	1,820,000
V	Louisiana, Arkansas, Oklahoma, Texas, New Mexico, and western Mississippi	7	8	365,000	13	431,000	796,000
VI	North Dakota, South Dakota, western Minnesota, eastern Montana, Wyoming, Colorado, Kansas, southwestern Missouri, small part of Iowa, major part of Nebraska	4	4	95,000			95,000
VII	Washington Oregon, Idaho, Utah, major part of Montana	5	6	325,000	5	990,000	1,315,000
VIII	Nevada, California, Arizona	3	3	210,000	13	530,500	740,500
Totals		78	111	8,675,000	70	4,890,500	13,565,500

The Commission's report points out that the resulting annual output of approximately 2,500,000 kw of new steam-electric and 1,000,000 kw of new hydroelectric generating units will insure power supply for the maximum Defense effort as presently conceived, assuming approximately 30 per cent displacement of normal loads.

Responsibility for Defense power planning including the FPC program, has been vested in a new agency created by the Office of Production Management and headed by J. A. Krug, former manager of power for the Tennessee Valley Authority, as Defense power co-ordinator. The new unit, which will work closely with the FPC, also has a consulting board on which both publicly and privately owned utilities are represented. Among these consultants are: Philip Sporn (A'20, F'30) American Gas and Electric Corporation; J. Moore, Electric Bond and Share; E. W. Morehouse, Associated Gas and Electric Company trustees; K. M. Irwin and Constantine Bary (A'25) Philadelphia Electric Company. John C. Parker (A'04, F'12) vice-president, Consolidated Edison Company of New York, Inc., and Fred Schaff, Superheater Company, have been appointed to the staff of the OPM power division to handle priorities.

Three members of the FPC staff also have been appointed to work with the OPM power division on the Defense power program. W. S. Youngman, general counsel for the Commission, G. H. Buck, engineer in charge of the power supply section, FPC defense power staff, and W. E. Caine, rate expert, will act as liaison between the two agencies.

Power Supply and the Aluminum Situation

A recent press release from the United States Chamber of Commerce, Washington, D. C., asserts that with current expansions of electric utility systems, the power outlook for the country as a whole this year indicates that generating capacity available will exceed peak demands by a margin of nearly 30 per cent, except for reductions in effective capacity resulting from the spring drought, particularly in the south eastern states and along the eastern seaboard. It is pointed out that "the placing of additional orders for generators to parallel the stepping-up of defense operations cannot possibly result in delivery before 1943 or 1944," because of the priority given to steam turbine production for naval vessels as compared with the needs in private utility plants. The belief is expressed that most of the new power demands that may be developed during the next 18 months will have to be met through a more efficient utilization of present capacity.

Briefly referring to the relationship between electric power and aluminum production, the Chamber of Commerce release points out that power to produce aluminum heretofore has never been a service or responsibility of private utility companies, since the aluminum companies generated their own power until they began to purchase power from the Tennessee Valley Authority.

In an effort to secure first-hand information concerning the presently confused question of adequacy of aluminum supply for defense purposes, the National Association of Manufacturers recently made a nation-wide telegraphic survey of 20 airplane and other defense production centers. According to NAM, quoting its president Walter D. Fuller, the survey "indicates that production and delivery of vital armament equipment has not been delayed to date by a shortage of the white metal," but that "there is no assurance that such a shortage might not develop in the future as the defense program expands, and the mere finding that there is no current shortage should not be interpreted as an effort to discourage collection of aluminum household utensils or other methods of conserving the civilian use of this much needed metal."

The survey indicated that the larger fabricating companies, being more familiar with priorities procedure and with the necessity of provision for advance stock, have been able to maintain adequate stocks for current orders, whereas some of the smaller concerns failed to obtain proper priority ratings and consequently are experiencing difficulties in obtaining aluminum deliveries. The survey showed that practically no aluminum is now being obtained by nondefense industries, such manufacturers either laying off employees or turning to substitute metals or plastics.

FPC CREATES SOUTHEASTERN POWER GRID

The power shortage in the southeastern United States, brought about in the early summer by abnormally low rainfall and tremendously increased power requirements for defense industries in that area, caused the Federal Power Commission to make the first use of its emergency powers. Declaring an emergency to exist, the Commission has ordered a series of interconnections among power companies, municipal plants, and REA co-operatives, and urged curtailment of the use of electricity for domestic and commercial purposes and in nondefense industries. Completion of the interconnections, some of which require as much as six months to construct, will make available to the 17 states affected additional capacity estimated at 200,000 kw. The interconnections were declared by the Commission to be the result of a series of studies and conferences on the part of the Commission with publicly and privately owned utilities to devise ways of meeting the Southeastern power emergency.

Increased rainfall during July relieved the shortage to some extent, but a program of power conservation for the region was launched officially by the Office of Production Management to secure more power for defense production, notably aluminum. To stimulate conservation, the United States Army Air Corps approved a plan to dedicate Army fighting planes to communities which save their assigned quotas of power. Since the aluminum required for a large bomber takes about 100,000 kilowatt-hours to produce, a community which saves that amount of power will in effect have contributed enough to build the plane. Awards will be made on a sliding scale to enable small communities as well as large to participate.

MORE POOLS PROPOSED

Two more power pools to tap reserves for aluminum production were announced by Defense Power Co-ordinator J. A. Krug of the OPM as in process of formation late in July. One includes New York, eastern Pennsylvania, New Jersey, and New England for the production of 150,000,000 pounds of aluminum annually in upper New York State; the other includes power from Arkansas, Oklahoma, Texas, Louisiana, Missouri, and Kansas, for production of 100,000,000 pounds of aluminum in Arkansas and for magnesium capacity in Texas. Both are made possible largely by the voluntary co-operation of the utilities involved, Mr. Krug said.

ALUMINUM GETS POWER PRIORITIES

Acting for the stated purpose of insuring power supply for defense production of aluminum, the Federal Power Commission on June 28 directed the Carolina Aluminum Company to reduce contract deliveries of electric energy to the Duke Power Company, following reports that such deliveries threatened to increase the prevailing power shortage in the Southeast by drawing down water in reservoirs. On request of the Aluminum Company of America, the Commission on July 2 authorized the Niagara Falls Power Company to supply an additional 500 kw of power immediately to increase defense production of aluminum in New York State. The additional power will be provided from the temporary emergency diversion by the United States of an additional 5,000 cubic feet of water per second from the Niagara River. The additional diversion, authorized by the Commission immediately following Senate approval on June 12 of a special agreement with Canada, provides 64,100 kw of power. Subsequently the Commission allotted the remainder of this additional power to 15 defense industries in the Buffalo-Niagara area, increasing the Aluminum Company's allotment to 1,200 kw. If any of the industries affected are unable to make full use of their allotment of emergency defense power for two consecutive months, the Commission may reallot the unused portion.

TVA TO OPERATE ALCOA POWER SYSTEM

The five-dam hydroelectric system of the Aluminum Company of America on the Little Tennessee River will be operated by the Tennessee Valley Authority, under the terms of a contract signed August 15. Announcing the contract, TVA states that it "will not assume ownership of the company's plants but will direct and control their operations, and will integrate them with its own extensive system of dams in such a way as to obtain the maximum public usefulness of the water in the entire Tennessee River watershed." The contract also provides for the acquisition by TVA of the Fontana dam site, which the company has owned for 30 years, and which the TVA proposes to develop at an estimated cost of $50,000,000. Construction of the dam has been approved by the Office of Production Management as a defense necessity, and will begin as soon as Congress provides the necessary funds.

Grand Coulee Power Will Supplement Bonneville for Defense Industries

Scheduled to start operation in August, the first of three identical 108,000-kw generators at Grand Coulee Dam will begin to deliver power to the newly created defense industries in the Northwest, supplementing Bonneville Dam, which is reported to be operating at full capacity. Two more generators are being assembled at the West power house, for operation in December 1941 and spring 1942 respectively. When completed, Grand Coulee will have 18 generators of the 108,000-kw capacity, the largest yet built in the United States; a total capacity of 1,620,000 kw under favorable water conditions.

Industries to use the power from Bonneville and Grand Coulee have been brought to the region by the Defense effort. Production of aluminum beginning in August at the Longview, Wash., plant of the Reynolds Metals Company is expected to use 60,000 kw by May 1942. Five plants of the Aluminum Company of America, Vancouver, Wash., now use 172,500 kw. These, with three government-owned plants in the area, which are scheduled for completion in about 18 months, will bring aluminum production in the Pacific Northwest to about 400,000,000 pounds annually, an amount which represents about two-thirds of the estimated 1942 demand for the Pacific Coast, about one-fourth of anticipated United States production for that year. Other defense industries now drawing power from Bonneville-Grand Coulee are the Pacific Carbide and Alloys Company and the Oregon Shipbuilding Company. The Pennsylvania Salt Manufacturing Company (chlorate for explosives), Electrometallurgical Company (calcium carbide and eventually ferro-alloys for steel), and a government built and leased magnesium plant at Spokane are expected to start operations during 1942. Efforts currently are being made to secure fabricating plants for the area.

New Steam-Electric Units Ordered

Alabama Power Company has ordered a 60,000-kw turbogenerator from General Electric Company, to be installed in its Gorgas Number 2 steam plant. This unit, the second of its size to be installed in this plant, is expected to be ready for operation May 1, 1943.

Cleveland Electric Illuminating Company has ordered a 50,000-kw turbogenerator, also from General Electric, for installation at its Avon power plant. Scheduled for operation in the fall of 1943, the new unit is said to be "100 per cent for National Defense." Two generators, with a total dependable capacity of 144,000 kw, are now under construction for the company's Lake Shore plant. The company is spending approximately $13,300,000 this year for new facilities.

Union Electric Company of Missouri has ordered a second 80,000-kw generator to be installed at its Venice Number 2 power plant now under construction at Venice, Ill. The first 80,000-kw unit is now on order for delivery in the fall of 1942; delivery on the second is expected in June 1943. Both are being built by the General Electric Company.

The new plant will also contain two 40,000-kw units, now under construction at Allis-Chalmers Manufacturing Company. The new plant and modernization of another plant will provide an increase of 265,000 kw in capacity, or about 40 per cent, to the Union Electric system. This plant is the objective of one of the inspection trips offered to those who attend the AIEE South West District meeting in St. Louis, October 8–10, 1941.

Minnesota Power and Light Company will install a new 33,500-horsepower generating unit at the company's Duluth, Minn., steam plant, doubling the capacity of the plant. The unit will be completed in 1943. A 17,000-horsepower steam electric plant is now under construction by the Superior Water, Light, and Power Company, Superior, Minn., to be completed in 1942. The two units will provide an additional 50,000 horsepower for the interconnected transmission systems of the companies.

FPC Hearing Scheduled on Pit River Development

The Pacific Gas and Electric Company has notified the Federal Power Commission of its unwillingness to accept the conditions imposed with the licensing of the Cresta and Pulga developments on the north fork of the Feather River and its intention to begin construction instead on a previously planned new development on the Pit River, which would utilize equipment and materials previously ordered for the Feather River plants. On advice of the Commission, the company filed a declaration of intention for the Pit River project, and public hearings were set for August 18. Subsequently the Commission again rescinded the license for the Cresta and Pulga plants (*EE, Apr. '41, p. 188–9; July '41, p. 358*). Special conditions imposed with the license for the Cresta and Pulga plants required the approval of the Commission for any increase of generating capacity which would make available more than 5,000 kw additional capacity at any one plant or from any one source or a total of 20,000 kw additional capacity; and imposed other restrictions relating to the company's Big Bend development, also on the north fork of the Feather River.

Commercial Aviation in the Defense Picture

Shipments of heavy industry products by air express showed a gain of 108 per cent for April 1941 over April 1939, according to recently reported statistics from the Air Express division of Railway Express Agency. The largest increase, 287 per cent, was shown by shipments to and from airplane plants, chiefly subassemblies, shortages, tools, instruments, and drawings. A large proportion of all express carried from eastern centers to the west coast consists of shipments from parts manufacturers to the large aircraft shops, the report shows. Regular daily scheduled shipments keep production lines moving; chartered planes handle emergency consignments.

One instance cited for the use of air express in transporting heavy shipments to speed the defense program was that of six circuit breakers to be used in a new defense plant. Weighing a total of 2,600 pounds, the six circuit breakers were loaded by the manufacturer in Philadelphia onto a regular DC-3 air liner ferried from New York for the purpose; flown to New York, and sent on successive regular trips by air express to their destination in Detroit. The entire shipment was delivered the same day it left Philadelphia.

AIR FREIGHT UNIT FORMED

Competing with the United States Air Mail and the Air Express division of Railway Express Agency, United States Freight Company has formed a subsidiary, Universal Air Freight Company, which will pick up shipments at New York and Detroit for direct air delivery at Chicago, Cleveland, Dallas, Denver, Des Moines, Kansas City, Los Angeles, Minneapolis, Omaha, St. Paul, and Tulsa. The company will carry a one-pound package from New York to Los Angeles in 16 hours for 65 cents. The air mail cost of similar service is 95 cents. Packages under 15 pounds will be picked up by Postal Telegraph boys for Universal at no extra charge to the customer.

MORE AIRPORTS

Funds have been voted by Congress to complete the Civil Aeronautics Authority's program of building and improving 250 civil airports of emergency military value, and to carry out improvements at 149 additional airports. An appropriation of $94,978,000 has been voted for the CAA and expenditures of about $40,000,000 toward the program also will be made by the Works Progress Administration. The airport sites will be chosen for their military value by a board consisting of the secretaries of War, Navy, and Commerce.

PLANE PRIORITIES

Conflict between Army demands and the currently growing boom in commercial air transport is resulting in studies by Congress and by the Civil Aeronautics Authority on civil air transport needs. Although estimates indicate that the transport lines could use from 100 to 150 more transports, attempts to get them have conflicted with Army and aid-to-Britain needs. If commercial lines can prove their importance in the defense program, they may be able to get priority on planes. Air transport to Latin America is regarded as vital to hemisphere defense, but development of American-controlled lines to replace German and Italian airlines in South American countries toward which diplomatic progress has been made, is reported to be held up by lack of equipment. The Army is reported to oppose letting domestic commercial lines have the equipment they want, claiming that much domestic transport can be shifted to railroads or highway. Commercial aviation men, however, see the industry as a reservoir of trained men and equipment; propose that the commercial lines be allowed to accumulate 500 planes, all of which could be taken over by the Government in any sudden emergency.

The foregoing, and many other current trends and developments, give emphasis to the recommendations made by Grover Loening in his article "Future Trends in Air Transportation" (*EE, Jan. '41, p. 57–63*).

Engineering Defense Training Broadened in Scope

The Engineering Defense Training program sponsored by the United States Office of Education has been broadened to include defense training in physics, chemistry, and industrial management. Institutions granting degrees in those subjects are now eligible to participate in the program, under which short intensive courses are given to present and prospective workers in defense industries. Inclusion of nonengineering institutions was authorized in a bill approved by Congress July 1, 1941, appropriating an additional $17,500,000 to carry on the educational program. The original program was financed by a $9,000,000 appropriation approved October 9, 1940, of which $8,795,171 had been allocated by June 30, 1941. Under its provisions approximately 2,300 courses have been set up for some 130,000 students by 144 engineering colleges in 47 of the United States, the District of Columbia, and Puerto Rico. (See *EE, Nov. '40, p. 478; Dec. '40, p. 521; Feb. '41, p. 92.*)

Three new members of the advisory committee have been appointed to consult on the new aspects of the program, the title of which has been changed to "Engineering, Science, and Management Defense Training". The new members are Homer L. Dodge, dean of the graduate school, University of Oklahoma, who will advise on the training of physicists; Clare E. Griffin, dean of the school of business administration, University of Michigan, who will advise on the training of production supervisors; and N. W. Rakestraw, professor of chemistry, Brown University, who will advise on the training of chemists.

Under a recently appointed subcommittee on education of the Joint Army and Navy Committee on Welfare and Recreation, plans are being developed for an educational program for men in Army and Navy service, according to an announcement from the American Council on Education. A number of colleges and universities adjacent to Army camps and Navy stations are planning cooperative programs either on a voluntary basis, or under the Engineering Defense Training program, the announcement states.

Radio, Electrical-Appliance Makers Meet Defense Restrictions

Among industries sharply affected by Defense priorities on materials and production, radio manufacturing and production of electrical appliances are conspicuous. Aluminum is being rationed currently to the radio industry at about 110,000 pounds per month—approximately one-third of its former consumption, with further reduction to about 70,000 pounds anticipated by the end of the year. Unable to get civilian priorities on aluminum, the industry has turned its research abilities to development of substitute materials; has found replacements for aluminum in all uses except for electrolytic capacitors. However, some of the substitutes are in turn being rationed and further substitutes are required.

With 1941–42 production of radio sets estimated at approximately 70 per cent of 1940 levels, the industry is making changes in manufacturing and merchandising policies which are said to include greater emphasis on high-priced sets and combinations (FM, phonograph), reduction in number of models, attempts to stabilize prices at higher levels, dealer-emphasis on repair and modernization services.

Meanwhile, defense orders, currently estimated at about 15 per cent of industry output and rapidly increasing, are regarded as the industry's lifeline. To date, most of these have gone to large manufacturers, but the trend is toward much wider distribution through the smaller firms. Reporting to stockholders in May, David Sarnoff, president of RCA, declared that defense orders received by that company to date totaled $36,500,000, and pointed out that work on some orders had been divided among as many as 109 subcontractors.

Manufacturers of electrical appliances face not only shortages of materials but reductions in volume imposed by the Office of Price Administration and Civilian Supply to save on consumption on metals and release labor and equipment for defense production. Such reductions are not yet decided but are expected to range between 30 and 50 per cent. With sales for the first six months of 1941 reaching all-time highs, cuts of from 33 per cent in electric washers, 42 per cent in refrigerator units, and 53 per cent in stoves could be made without bringing sales of any of these below 1939 levels, it is reported. In the manufacture of all major appliances, impending shortages of aluminum and other important metals for nondefense use already have resulted in shifts to available substitutes, and undoubtedly will require further and more drastic shifts. No substitute has been found as yet for the nickel required in the primary resistor of electrical heating devices; manufacturers are saving nickel for this purpose by substituting other materials elsewhere.

Electrical Manufacturers' Liaison Committee Formed

A committee of 24 representatives of the electrical manufacturing industry has been appointed to work with the Office of Production Management on defense problems. Typical of such problems are: temporary modifications of Federal specifications to permit use of substitutes, the conservation and substitution of materials, simplified practices, allocation of production capacity, and standardization of production. Attention will be especially directed toward spreading government purchases, through increased subcontracting and getting small plants to take on more direct orders.

Six members of the committee have been designated as a steering committee to work with the chief of the equipment and supplies branch of OPM's procurement division. These are:

W. J. Donald, National Electrical Manufacturers Association; Leonard Kebler, Ward Leonard Electric Company, Mt. Vernon, N. Y.; J. P. Shelley, Metropolitan Electric Manufacturing Company; W. E. Sprackling, Anaconda Wire and Cable Company; George Thomas, Jr., Thomas and Betts Company, Elizabeth, N. J.; George F. Hessler, Graybar Electric Company, New York, N. Y.

Other members of the committee are:

H. E. Blood, Norge division, Borg-Warner Company, Detroit, Mich.; C. L. Collens (A'07, M'40) Reliance Electric and Engineering Company, Cleveland, Ohio; Frederick Eisman, Revere Electrical Company, New York, N. Y.; Ralph Kelly, Westinghouse Electric and Manufacturing Company, New York, N. Y.; L. E. Latham, E. B. Latham and Company, New York, N. Y.; F. W. Magin, Square-D Company, Detroit, Mich.; R. W. McChesney (A'20, M'28) National Electrical Contractors Association; J. W. McNair (A'25) American Standards Association; Everett Morss, Simplex Wire and Cable Company, Cambridge, Mass.; J. M. Newton (A'18, F'37) Oakes Electric Supply Company, Holyoke, Mass.; Matthew Porosky, Eagle Signal Corporation, Boston, Mass.; A. C. Prange, General Electric Supply Corporation, Bridgeport, Conn.; C. A. Scott, Rome Cable Corporation, Rome, N. Y.; E. O. Shreve (A'06) General Electric Company, Schenectady, N. Y.; D. M. Simmons (A'22, F'28) General Cable Corporation, New York, N. Y.; P. J. Smith, American Society for Testing Materials; C. E. Swartzbaugh, Swartzbaugh Manufacturing Company, Toledo, Ohio; Walter Williamson, Westinghouse Electric Supply Company, New York, N. Y.

Appointment of this committee is part of a general program aiming at a working relationship between government and industry, on a commodity basis. About 30 committees are expected to be appointed, each paralleling a commodity unit in the OPM. Subcommittees and temporary industry groups also will be appointed to handle details and special problems. The function of the committees is purely advisory.

Unit for Scientific Research Headed by Vannevar Bush

To co-ordinate all scientific activities connected with National Defense, the Office of Scientific Research and Development has been created within the Office of Emergency Management by executive order of the President. The new office will serve as liaison agency for several scientific groups which have been working independently. It also is authorized to "initiate and support" research programs for the production of new defense materials and methods, and medical research programs having defense value. Funds for such programs will be provided by Congressional appropriation. Previous groups of this type have had advisory powers only.

Doctor Vannevar Bush (A'15, F'24) president of the Carnegie Institution of Washington and until now chairman of the National Defense Research Committee, has been appointed to head the Office of Scientific Research and Development. President James B. Conant of Harvard University succeeds Doctor Bush as chairman of the National Defense Research Committee which will be one of the principal agencies for carrying on activities initiated by the new body. Other existing agencies which will report through Doctor Bush's organization include the National Advisory Committee for Aeronautics and the Health and Medical Committee established by the Council of National Defense; distinctly Defense activities of such established Government bureaus as the Bureau of Mines and National Bureau of Standards also will come under its control.

The Office of Scientific Research and Development will work closely with the Office of Production Management, the Office of Civilian Defense, the War and Navy Departments, in finding useful scientific methods, devices, and materials, which those agencies can put into use. Provision also is made for co-operation with British research bodies.

Defense Unemployment

The shift from peace-time production of consumer goods to concentration on defense industries in the United States is producing its own brand of unemployment which, according to Price Administrator Leon Henderson, may affect some 2,000,000 or more workers. Consumer-goods industries are faced with difficulty in obtaining raw materials, as a result of defense priorities, and are likely to be compelled to reduce operations drastically. Unemployment will result, at least during the adjustment period. The household equipment industry is among those already seriously affected, along with silk, automobiles, gasoline distribution, home building, and other consumer industries. Some reports currently in circulation indicate that such consumer goods as radios and certain electrical appliances may be completely out of production within the year.

When the shift to armament economy is completed, it is expected that increased activity will create a growing demand for workers, at least for the duration of Defense production. An example of efforts to meet the immediate problems is found in the Office of Production Management's program to put the silk industry back at work using substitute materials. Substituting materials not needed for defense purposes or finding a way to use plant and machinery in the defense program seem to be the chief solutions open at present to manufacturers of peacetime products.

Allis-Chalmers Creates Priorities Department. A new administrative department, known as "priorities management" has been set up by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., to handle details relating to priorities. Functions of the department will be to present company problems to government agencies, co-ordinate information for other departments of the company, help determine shop schedules when jobs with the same priorities rating conflict.

Positions to Be Filled Through Civil Service Examination

Notice of the following positions, which will be filled through civil service examinations, is published here as a service to members of the Institute. Application forms and full information as to requirements for examinations may be obtained from the secretary of the Board of United States Civil Service Examiners at any first- or second-class post office, or from the United States Civil Service Commission, Washington, D. C. Applications will be accepted until further notice.

Industrial Specialists. The Government continues its search for specialists in all branches of industry and business. The Federal Civil Service examination for industrial specialist, announced on July 7, has been amended to remain open for receipt of applications until further notice. The National Defense program needs men with experience in one or more of the following fields: Iron and steel; nonferrous metals; machine tools; ordnance; aircraft, marine, and automotive equipment; railroad repair shops; radio and other electrical equipment, supplies and apparatus; textiles; forest products; paper; printing and publishing; chemicals and allied products; plastics; petroleum and coal products; rubber products; stone, clay, and glass products; leather and its manufactures; food and kindred products. Salaries range from $2,600 to $5,600 in the various grades. No written examination is given.

Naval Architects and Marine Engineers. Revised examinations have just been announced by the Civil Service Commission for persons qualified in all branches of naval architecture and marine engineering. Persons are particularly needed for filling positions in the assistant and associate grades ($2,600 and $3,200 a year, respectively). However, naval architects or marine engineers qualified to fill all the grades (salaries range as high as $5,600 a year) are urged to apply at once, although applications will be accepted until June 30, 1942. The Commission will not accept applications from those persons who successfully passed the examinations for Naval Architect or Marine Engineer positions under the terms of Announcements No. 50, 51, 111, and 112 of 1940, which closed on June 30, 1941, unless they are now eligible for rating in a higher grade. Persons who have been placed on the Commission's employment list, as a result of the previous examinations will be retained on the new list to be established as a result of the examinations just announced. The experience and education requirements have been modified. For instance, experience need no longer be in any specific branch. Complete substitution of experience is allowed for the four years of college study in engineering or naval architecture. However, if more than two years of experience is substituted in this way, it must have been in strictly technical work and of such scope as to indicate a person's professional knowledge of the fundamentals of engineering or naval architecture. In addition to this education or experience, appropriate professional naval architectural or engineering experience is required, and some of this experience must have demonstrated outstanding professional attainment in the field. Persons who have done graduate study in engineering or naval architecture may substitute three years of such study for the general experience required. Applicants who have completed a four-year college course in either engineering or naval architecture may also substitute certain shipyard experience for the general experience. A maximum of two years as journeyman or helper in a shipyard in any of the following trades may be utilized in the substitution: (1) for the naval architect—loftsman, shipfitter, template maker, shipjoiner, shipyard estimator, and ship draftsman; (2) for the marine engineer—boilermaker, patternmaker, pipefitter, machinist, electrician, shipyard estimator, or ship machinery draftsman.

Photogrammetric and Topographic Engineering Aids. Persons trained in engineering again are called upon for Government service. An examination has just been announced by the Civil Service Commission for engineering aids in two fields: photogrammetry and topography. Salaries range from $1,620 to $2,600 a year. Persons are particularly needed in the three lower grades (paying $1,620 to $2,000) in the field of photogrammetry. However, any person qualified for any of these positions is urged to file his application at once with the Commission's Washington office where it will be rated as soon as practicable after receipt. Applications will be accepted until June 30, 1942. Engineering aids appointed from this examination will perform engineering work in photogrammetric, geodetic, hydrographic, topographic, or cadastral surveying. They will plot survey notes or control points, and project and check scales of photographs. The operation of laboratory apparatus or survey instruments will also be a part of the work. A written test will not be given; competitors will be rated on their education and experience. Although the completion of 14 units of high-school study is a basic requirement applicants may substitute an additional six months of engineering experience for that education. In addition they must have had responsible civil engineering experience including some work in the optional branch selected. Persons who have had the required civil-engineering experience but who have not had the specialized work in one of the optional branches may also qualify for some of the positions provided they have successfully completed an approved defense training course in photogrammetry and aerial photographic mapping, or in topographic mapping and closely related subjects. A number of substitutions are provided for the general civil-engineering experience. Under certain conditions college study in any branch of engineering, in physics, chemistry, mathematics, or geology may be used to fill a portion of the experience requirement. Persons who have studied in night school or done part-time day study may also be permitted to utilize that study for a portion of the experience.

Education

Engineering Experiment Station at Arizona. The establishment of an engineering experiment station for the purpose of research into problems of particular interest in the Southwest, has been voted by the board of regents of the University of Arizona. Members of the faculties of the colleges of engineering and of mines have been appointed to various positions on the staff, among them J. C. Clark (A'09, M'21), electrical engineer, and O. H. Polk (A'35), associate electrical engineer.

High-Voltage Generator Set Up at NYU. A high-voltage surge generator capable of generating 350,000 volts has been constructed at the New York University college of engineering by Ralph E. Armington (Enrolled Student) of Medford, Mass., under the supervision of Professor Harold Torgersen (A'31, M'39). The generator is the second unit in a newly established high-voltage laboratory at the college. The first unit was a high-voltage transformer installed last fall when the laboratory was opened. The new apparatus will be used in high-voltage research for the testing of insulating materials and insulators. It has been designed and constructed chiefly for the use of graduate students and research engineers, but will be used also for the study of problems presented by industrial laboratories. With Professor Philip Greenstein (A'29) Professor Torgersen has developed a high-speed high-voltage cathode-ray oscillograph to be used in connection with the surge generator.

General Electric Awards Steinmetz Scholarships. A General Electric Company employee, and the son of an employee of the affiliated Elmira Foundry Company, are the 1941 winners of the Charles P. Steinmetz Memorial Scholarships established by the company in 1924. Both will enter the electrical engineering course at Union College in Schenectady, N. Y., this fall. They are E. L. Bates, Jr., who is employed in the blueprint department, Pittsfield, Mass., and A. J. Taggi, son of Anthony Taggi, a molder in the Elmira Foundry Company, Elmira, N. Y.

Westinghouse Makes War Memorial Awards. Sons of five employees of the Westinghouse Electric and Manufacturing Company have been selected as the 1941 winners of the War Memorial Scholarships established in 1919 by the company in honor of its 5,000 employees who served in the World War. Candidates must be either sons of Westinghouse employees or young workers themselves, and winners were chosen on the basis of competitive examinations held in 21 cities, with 60 candidates participating. The awards provide $500 a year to be used in technical courses at colleges chosen by the recipients. This year's winners, their selected colleges, and courses of study are:

A. W. Kimball, Jr., Purdue University, chemical engineering; J. W. Hines, Carnegie Institute of Technology, electrical engineering; C. H. Smith, Jr., Massachusetts Institute of Technology, electrical engineering; W. E. Keene, Carnegie Institute of Technology, management engineering; and R. E. Brueckmann, Princeton University, electrical engineering.

Industry

Electric Energy Production and Capacity Reach Highs in 1940

The 1940 production of electric energy in the United States exceeded the previous all-time record reached in 1939 by more than 14,600,000,000 kilowatt-hours, or 11.2 per cent according to a recent report of the Federal Power Commission. Installed capacity of electric generating plants at the end of 1940 likewise reached a new high of 41,638,956 kw, a net increase over 1939 of 1,321,032 kw or 3.3 per cent.

The total production for all types of prime movers for 1940 was 144,984,565,000 kilowatt-hours. Privately owned utilities produced 127,642,231,000 kilowatt-hours from a total installed capacity of 35,500,651 kw, and publicly owned plants produced 17,342,334,000 kilowatt-hours from a total installed capacity of 6,138,305 kw, the report shows.

The increased utilization of electric energy during 1940 is reflected in the higher plant factor which, the report shows, increased to 40.3 per cent from 37.5 per cent in 1939. The plant factor shown in tables in the report is the ratio of the actual output in kilowatt-hours to the potential output on the basis of 100 per cent use of the installed capacity for every hour in the year. The installed capacity was assumed to be the capacity in service at the end of the preceding year plus one-half of the increase during the year in question.

Comparison of production of electric energy and capacity of generating plants for 1940 and 1939 is shown in the table at the bottom of the page, taken from the report.

Although the total capacity in service at the end of 1940 increased 1,321,032 kw over the preceding year, the total number of generating plants decreased from 4,126 in 1939 to 4,109 in 1940, the report shows. The total number of privately owned plants reporting to the Commission decreased from 2,925 in 1939 to 2,864 in 1940, while the

	Production 1,000's of Kw-Hr		Capacity (Kw)		Plant Factor (Per Cent)	
	1940	1939	1940	1939	1940	1939
Hydro	47,752,627	44,021,631	11,675,300	11,415,165	47.1	44.7
Steam	95,674,653	85,006,941	29,019,102	28,046,948	38.2	35.1
I.C.	1,557,285	1,307,478	944,554	855,811	19.7	18.3
Total	144,984,565	130,336,050	41,638,956	40,317,924	40.3	37.5

total number of publicly owned plants increased from 1,201 to 1,245 during the same interval.

The number of establishments and number of plants are shown by class ownership in a table in the report as follows:

Class of Ownership	Number of Establishments	Number of Plants
Total all classes of ownership	1,696	4,109
Privately owned		
Electric utilities	561	2,676
Mining & manufacturing	130	163
Railways and railroads	17	25
Subtotal	708	2,864
Publicly owned		
Municipal electric utilities	897	1,052
Federal		
Bureau of reclamation	1	14
Other projects	4	32
Co-operatives, power districts, state projects, etc.	47	100
Noncentral stations	39	47
Subtotal	988	1,245

Production and installed capacity for 1940 within the nine geographic divisions reflected substantial increases over comparable figures for 1939. The 1940 report shows totals for each geographic division by months and the total number of plants and capacity at the end of the year. Comparative data on production, generating capacity, and number of plants by regions are shown in the following table:

		Total Production 1,000's of Kw-Hr	Number of Plants	Capacity (Kw)
New England	(1940)	8,968,302	353	3,063,641
	(1939)	8,350,362	357	3,028,280
Middle Atlantic	(1940)	36,383,373	412	9,878,243
	(1939)	32,969,952	419	9,746,991
East North Central	(1940)	33,612,066	700	9,489,020
	(1939)	29,995,003	699	9,069,488
West North Central	(1940)	8,481,207	876	3,316,710
	(1939)	7,859,695	867	3,157,538
South Atlantic	(1940)	17,617,508	426	5,171,478
	(1939)	15,190,108	434	4,843,202
East South Central	(1940)	8,471,576	187	2,144,322
	(1939)	6,967,949	208	2,001,627
West South Central	(1940)	7,433,502	439	2,104,851
	(1939)	6,979,694	431	2,041,071
Mountain	(1940)	8,544,075	405	2,217,379
	(1939)	7,492,621	402	2,156,800
Pacific	(1940)	15,472,956	311	4,253,312
	(1939)	14,530,666	309	4,272,927

Copies of the recently issued report may be obtained from the Federal Power Commission, Washington, D. C., at 25 cents each, remittance to accompany order. Stamps are not acceptable. For convenience in ordering, the report may be referred to as FPC S-13.

FPC Applies "Prudent Investment" Theory. Establishing a new basis for power rates, the Federal Power Commission has ordered Chicago District Electric Generating Corporation to reduce its rates to the Commonwealth Edison Company of Chicago by $521,978 annually through reducing the corporation's rate base to $34,355,469 and establishing its rate of return at $5\frac{1}{2}$ per cent. Commonwealth Edison and Northern Indiana Public Service Company, supplying consumers in the Chicago and northern Indiana area, buy the entire output of the corporation's generating plant. The Commission's precedent-breaking decision applying the "prudent investment" theory as a basis for rate-making terminated a three-year investigation.

Von Siemens Dies in Berlin. Carl Friedrich von Siemens, German electrical industrialist, died July 10, 1941, at Berlin. He was 68 years of age. The son of Warner Siemens, founder of the Siemens concerns, Doctor Siemens entered the firm in 1899, and in 1902 was made manager of a branch of the London firm of Siemens Brothers and Company. In 1908 he returned to Berlin, and in 1912 became chairman of the board of directors of the Siemens Schuckert Works. He became chairman of the supervisory board of Siemens and Halske and Siemens and Schuckert in 1919, and it was under his directorship that the concern became one of the most important electrical undertakings in the world.

Charles Clark Robinson, superintendent of electric power plants for the Union Electric Company of Missouri, St. Louis, died July 18 at Sturgeon Bay, Wisconsin, following a paralytic stroke. Mr. Robinson was an electrical engineering graduate from the University of Missouri (1904). He was successively affiliated with the Telluride Power Company of Provo, Utah (1904–09); the Central Colorado Power Company, Denver (1909–12); the Union Electric Company (1912–41). Mr. Robinson was affiliated with the AIEE from August 25, 1905 until April 30, 1939.

F. E. Weymouth Dies. Frank Elwin Weymouth, general manager and chief engineer of the Metropolitan Water District of Southern California, Los Angeles, Calif., died July 22, 1941. Mr. Weymouth received the degrees of bachelor of civil engineering, 1896, and doctor of engineering, 1934, from the University of Maine. From 1899 to 1901 he was with the Isthmian Canal Commission, serving at various times in Nicaragua, Central America, and Washington, D. C. After a year as resident engineer with a South American railroad company, he became project engineer with the United States Reclamation service in 1902, supervising planning and construction on several large projects, and becoming chief engineer in 1920. He had been with the Metropolitan Water District of Southern California since 1929, first as chief engineer, and as general manager and chief engineer since 1932.

Other Societies •

IES Formulates Revised Practice for Residence Lighting

A revised "Recommended Practice for the Illumination Performance of Residential Luminaires" has been formulated by the Illuminating Engineering Society, and adopted by the American Lighting Equipment Association. It is based on modifications and revisions agreed upon by the IES committee on residence lighting and the specifications committee of the ALEA. The revisions are intended to insure better lighting performance while allowing adequate latitude for decorative design of residential lighting fixtures. To a greater extent than has been heretofore attempted, the new "practice" classifies fixtures with respect to decoration and function, and lays down rules and principles governing their illumination characteristics.

NRC Committee Sponsors Electrical Insulation Symposium

A symposium on electrical insulation materials, sponsored by the National Research Council committee on chemistry, conference on electrical insulation, will be part of the program of the coming meeting of the

Future Meetings of Other Societies

American Association for the Advancement of Science. Convention, September 22–26, 1941, Chicago, Ill.

American Institute of Chemical Engineers. 34th annual meeting, November 3–5, 1941, Virginia Beach, Va.

American Society of Civil Engineers. Fall meeting, October 15–17, 1941, Chicago, Ill.

American Society of Mechanical Engineers. Fall meeting, October 12–15, 1941, Louisville, Ky.

Annual meeting, December 1–5, 1941, New York, N. Y.

American Welding Society. 22nd annual meeting, October 19–24, 1941, Philadelphia, Pa.

Association of Iron and Steel Engineers. Annual convention, September 23–26, 1941, Cleveland, O.

Illuminating Engineering Society. Annual convention, September 22–25, 1941, Atlanta, Ga.

National Metal Congress. October 20–22, 1941, Philadelphia Pa.

National Safety Council. 30th National Safety Congress and Exposition, October 6–10, 1941, Chicago, Ill.

Society of Automotive Engineers. National aircraft production meeting, October 30–November 1, 1941, Los Angeles, Calif.

National transportation and maintenance meeting, November 13, 14, 1941, Cleveland, O.

American Chemical Society at Atlantic City. The symposium will be held September 11, under the auspices of the division of industrial and engineering chemistry of the American Chemical Society. The program of the symposium is as follows:

INFLUENCE OF OXIDATION ON THE DIELECTRIC PROPERTIES OF HYDROCARBONS AND HYDROCARBON OILS. **J. C. Balsbaugh, A. G. Assaf,** and **J. L. Oncley,** Massachusetts Institute of Technology

PAPER DIELECTRICS CONTAINING CHLORINATED IMPREGNANTS—DETERIORATION IN D-C FIELDS. **D. A. McLean, L. Egerton, G. T. Kohman,** and **M. Brotherton,** Bell Telephone Laboratories, Inc.

THE INFLUENCE OF REFINING TECHNIQUE ON ELECTRICAL STABILITY OF MINERAL OIL TREATED DIELECTRICS. **F. M. Clark** and **E. L. Raab,** General Electric Company, Pittsfield, Mass.

THEORY OF DIELECTRIC LOSS IN POLAR POLYMERS. **John G. Kirkwood,** Cornell University.

DEPENDENCE OF DIELECTRIC LOSS ON MOLECULAR WEIGHT IN THE SYSTEM OF POLYVINYL CHLORIDE–DIPHENYL. **R. M. Fuoss,** General Electric Company, Schenectady, N. Y.

RELATION OF DIELECTRIC PROPERTIES TO STRUCTURE OF LINEAR POLYAMIDES AND POLYESTERS. **W. A. Yager** and **W. O. Baker,** Bell Telephone Laboratories, Inc.

Wood Pole Standards Adopted by ASA. The American Standards Association has adopted formally as American Standards six tentative standards covering specifications for wood poles. The standards were prepared under the sponsorhsip of the ASA Telephone Group which is made up of the Bell Telephone System and the United States Independent Telephone Association. A consistent system of standards is fixed for the six major pole timbers of the United States, on the basis of tentative standards which have proved satisfactory through several years' trial use. Included in the standards are specifications for shape and straightness of grain, limits on departure from straightness, definition of minimum quality acceptable, and specifications for dimensions. Copies of the new edition of these standards may be ordered from the ASA Headquarters, 29 West 39th Street, New York, N. Y., at 20 cents each.

NEMA Revises Motor and Generator Standard. A revised standard covering motors and generators has been released by the National Electrical Manufacturers Association. The publication, No. 41-64, entitled "NEMA Motor and Generator Standards," supersedes publication No. 38-49 released in 1938. It contains all standards approved to date, and includes information as to standard dimensions, rating, and tests. Copies may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York, N. Y.; price $3.50 per copy.

Letters to the Editor • • •

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Total Security—A Challenge

To the Editor:

The address of Charles E. Wilson, president of the General Electric Company, published in the March issue of ELECTRICAL ENGINEERING, is most timely. His grave warning—that we must proceed promptly and on a realistic premise in the development of a program which will contribute to our "total security"—cannot be too strongly emphasized. His diagnosis—that the present world upheaval is a revolution of the masses who clamor for "more economic freedom and security"—is only too true. The masses sense correctly that "want in a new world of plenty" is unnatural and must be blamed on faulty leadership. His conclusion—that the present trends of corrective measures are in the wrong direction, as they all try to reach their goal of "more economic freedom and security" by curtailing "freedom" through growing government control—is also only too true. Mr. Wilson's firm belief in the free-enterprise system is fully justified. Its past 60 years performance and achievements are sufficient proof of its correctness.

In an intensive study of the "Social-Economic Problem" for the past 8 years on the novel basis of engineering research, the writer has arrived at the same general conclusions that Mr. Wilson expresses as to the nature of the present world upheaval and as to the need of finding a solution without destroying the free-enterprise system. As to the basic cause, effect, and consequential remedy, however, the writer's investigations lead to entirely different conclusions.

Without trying to argue any of Mr. Wilson's detailed suggestions, which in themselves might all prove helpful, the writer believes that these suggestions do not strike at the root of our trouble and therefore could not possibly bring the intended relief.

Mr. Wilson starts from the premise that our problem must be solved by economic means, because its cause is economic. This customarily assumed but tragically erroneous premise overlooks the fact that the problem confronting us is inseparably social-economic. The "power and machine age" with its abundance of machine forces has substituted permanently for a part of a nation's active man power and will do so at an ever greater rate.

This economic change has destroyed forever the past social equilibrium, in which, throughout the history of mankind, the whole manhood (*maximum* national man power) was required to perform a nation's work. Instead, the new condition is searching for a *new* social equilibrium, in which only a *minimum* of the national man power will be required for active service. The social effect under this new condition is a steady and unrelenting shift within the nation's manhood from active to superfluous (retired) manhood, with the whole of the manhood, however, remaining biologically responsible for the perpetuation of life, by mating and caring for its offspring.

While the cause of our new condition is thus economic, the effect must be considered as social, and accordingly the remedy to be applied must be social. Our present social-economic ills, including the present war, can thus be traced to one single basic cause—our mistaken attitude towards superfluous labor, by viewing such superfluous labor as a curse instead of recognizing it as the natural blessing of the new era.

The only solution for this new situation is to arrange for a freely and beneficially functioning shift from active to superfluous manhood by an adequate distribution scheme which will divide equitably the national produce among the whole manhood. This is possible by reorganizing a nation on the basis of a mutual retirement insurance, with income as basis and the income tax the premium on such retirement insurance. In actuality such income tax will be used to support the contemporary superfluous (retired) at their normal net existence level throughout their retirement in expectation that the same privilege be accorded to the contributor by the next generation, when he himself reaches the retirement age.

Mr. Wilson's suggestion that wise and courageous men from the ranks of free enterprise should get together is very valuable. But such get-together would be losing precious time if it were to continue to try to do the impossible of finding employment for the unemployed. Instead, the writer believes such get-together should concentrate on the verification of his contention that the problem is social; that its only solution is to provide for the complete and beneficial withdrawal of the superfluous man power from the labor market by means of a national retirement scheme; and that only such solution can restore the free functioning of the free-enterprise system and democracy itself.

Let large corporations with engineering research departments expand their work in this new direction by delegating philosophically inclined engineers to the most urgent task of "foundation engineering in the human-existence problem". The laws controlling this are just as rigid as those in the physical world. Though only qualitative analysis is feasible by such method, this limitation will not prove a handicap as it will be sufficient for such research to be able to indicate unmistakably the trend which our human actions will lead us to, that is, towards establishing heaven or hell on earth.

Mr. Wilson's clarion call augurs well! Total Security is possible! The free-enterprise system and a freely functioning democracy are essential if maximum freedom is to be assured as well. The technical machinery for this promising condition has been created by the achievements of the machine and power age, a living monument of the free-enterprise system.

Total security with maximum freedom is a challenge—a challenge which can be answered by the engineering profession! Shall we engineers meet it and help thereby save democracy from within? Or shall we ignore it and let ourselves be destroyed by the very machine we have helped to create?

The fate of modern civilization will be sealed by our answer and decision in this momentous question.

Paul Ackerman (A'13)

(Consulting engineer, Montreal, Quebec, Canada)

Editor's Note: Mr. Ackerman suggests that his "help and advice are available to anyone desirous to undertake the verification and propagation of the discovered social-economic truth" to which he refers in this letter. Readers wishing more detailed information on Mr. Ackerman's plan should write directly to him. Mimeographed copies of the complete presentation may be obtained by sending postal note of $1.00 per copy (postage included) to the author at 4078 Hingston Avenue, N. D. G., Montreal, Que., Canada.

Facts Versus Propaganda

To the Editor:

"Facts Versus Propaganda," in Electrical Engineering for August, pages 371–3, is one of perhaps a half-dozen articles on the general subject that have appeared in recent months. My thought for some years has been that the subject deserves much more attention than it has received in my lifetime.

My illustration for the method of teaching that Doctor Adams condemns is the building of a dump. Such a heap may be started at any time and any place, without preparation, plan, or foundation, and continued in the same way. Although the builder may collect a few social degrees while he is building, when he stops all he really has is another mental dump, plus the right to teach others to build the same way.

A comparatively short time ago, primitive man used to roast one of his fellow-primitives every spring, for insurance against famine. The more copious the tears of the roasted one, the more abundant the summer rainfall to come, and therefore the better the crops. This practice had the sanction of centuries, and primitive man was quite satisfied with his logical reasoning. What the victim thought did not count. He was so trussed up that all he could do was to roll from side to side above the fire, on the comfortable V-shaped broiler his considerate fellows had provided so that he might not die until after he had shed all his tears.

The logic and the torture were both flawless, despite the erroneous premise, so when a famine came the fault lay with the evil spirits who had led to the choice of a sacrifice deficient in his supply of tears. Because the sanction of centuries suffices for primitive minds, early primitive man persevered in his pleasant little pastime, and the annual crop of victims continued.

Today countless centuries of teaching by authority, instead of by experimentally determined fact and true reasoning, again are bearing fruit, just as through the ages. In the United States the pupils fall for Millers and Ponzis and other equally skillful spellbinders. In the "verboten" part of the world they fall for maniac Hitler. The fruits of the rubbish-dump method of teaching always have been vicious. Reason tells us that they always will be. Perhaps some day more of us will listen to reason. I hope Doctor Adams' article will have wide publicity.

H. H. Ketcham (A'13, M'23)

(Editor, International Correspondence Schools, Scranton, Pa.)

Books for Engineers

To the Editor:

As electrical engineer in charge of a small power system, the writer wishes to open the question of books for professional men. Conditions are not what they should be from the standpoint of practical value to the purchasers of many volumes covering engineering subjects. My contention is that if books are to be marketed they should serve their purpose as engineering aids.

As an example in my own experience two texts come to mind: "Symmetrical Components" by Wagner and Evans and "Electric Circuits" by the Electrical Engineering Staff of Massachusetts Institute of Technology. Having obtained these excellent treatises and seemingly having progressed slightly in masticating their contents, a deep disappointment arose. Of the various questions and problems presented for perusal, no answers were published. Evidently these productions were intended primarily as texts for engineering students, hence the secrecy. Requests for copies of the answers only bring the reply that answers are not available to the general public. Of course an engineer does not class himself as "general public", but he may be such.

It is well known that a maintenance, construction, and operation program presents so many and such varied problems that engineers charged with these responsibilities cannot devote a great deal of time to design and abstract theory. This is why it was the wish of the writer to check some of the known factors and values on his system with the results obtained in the theoretical way. If he were expert enough to feel that the correct result has been obtained for each problem, no text would be desired and the book would not have been purchased. It is unfair and negligent to dispose of these books to engineers without making all of their advantages available. It is felt that in the examples mentioned only a fraction of the book value is obtained.

Clark J. Wells (M'37)

(Power superintendent, United States Department of Interior, Coolidge, Ariz.)

Conserved-Pressure Air-Blast Circuit Breaker

To the Editor:

I should like to enquire by what method the assigned rating of the breaker described in the paper by W. R. Rankin and H. M. Bennett (*AIEE Trans., '41 (May), p. 193–7*) has been derived from the test results.

The test voltages given in table I of the paper (22, 44, 88 kv etc.) are presumably the nominal applied voltage in each case, and not the measured recovery voltage. Even if for the moment they are taken as recovery voltages (the real recovery voltage might of course be less) it seems difficult to justify the rating of 1,500 kva at 138 kv corresponding to a breaking capacity current of 6.3 ka.

Table A

Percentage of Rated Symmetrical Breaking Current (1)	Minimum Recovery Voltage Required by B.S.S. 116–1937 Part 2 as Percentage of System Voltage for Rating 1,500 Kva (2)	Actual Values of Test Current and Recovery Voltage Corresponding to Columns 1 and 2 Related to a Rating of 1,500 Mva 138 Kv		Results Obtained on Tests Taken From Table I of Paper	
		Ka (3)	Kv* (4)	Ka (5)	Kv (6)
10	95	0.63	114	1.61	132
30	95	1.89	114	1.61	132
60	60	3.8	72	3.6	88
100	30	6.3	36	4.4	44
				10.7	22

*These values are calculated by applying the percentages of column 2 to the equivalent single phase test voltages of $\frac{138\times1.5}{1.73}=120$ kv.

Columns 1, 2, 3, and 4 of table A give the values of test voltage and current required by B.S.S. 116–1937, Part 2, to correspond to a rating of 1,500 mva at 138 kv. The nearest results actually obtained according to the paper are shown in columns 5 and 6.

The maximum rating that could be assigned to the breaker according to the British specification is thus:

$$\frac{4.4}{6.3}\times1{,}500=1{,}050 \text{ mva at } 138 \text{ kv}$$

Alternatively, if the rating were based on the test at 10.7 ka, 22 kv the rated voltage would have to be reduced to

$$22\times\frac{1.73}{1.5}\times\frac{100}{30}=85 \text{ kv}$$

and the breaking capacity would become

$$10.7\times85\times1.73=1{,}570 \text{ mva}$$

C. C. Garrard (A'06)

(Head of switch and transformer works, General Electric Company, Ltd., Witton, Birmingham, England)

"Student Section" for EE

To the Editor:

For a while I thought a moratorium had been declared on the topic "A Simple Method of Calculating Power Factor" but I see in the August issue of Electrical Engineering that the discussion has started all over again. I'm not going to comment upon nor discuss this power-factor calculation (I had my say in the March 1941 issue), but I do want to comment upon the increased interest of student members toward Electrical Engineering as shown by their numerous contributions to the "Letters to the Editor" page.

I feel that the student membership in the AIEE is sufficiently large and the student interest in ELECTRICAL ENGINEERING is sufficiently great to warrant a page or two in this magazine devoted entirely to student discussions, letters, papers, news of student activities, enrollment, and so forth. This would create increased activity among the Student Branches which would result in an increase in student membership in the AIEE.

The benefits the electrical-engineering student would derive from such a "Student Section" are many. First, he would develop the style and technique of technical writing and expression. Second, his comments and criticisms on engineering education might give the educators a better understanding of the electrical-engineering student and so in time help him in his school work. Third, news of the activities of the different Student Branches would cause a greater affinity between Branches.

The handling of material for this "Student Section" could be put into the hands of a small group of students and the Branch secretaries could be given the added duty of college representative—or better, give the Branch vice-president something to do. Let him be the college representative.

I petition you to look into the possibilities of having a few pages of ELECTRICAL ENGINEERING devoted exclusively to the writings and news of student members and Student Branches and ask you student members who might read this letter to send a similar petition to G. Ross Henninger, editor of ELECTRICAL ENGINEERING and offer suggestions and convincing arguments that would warrant the existence of a "Student Section" in ELECTRICAL ENGINEERING.

SANFORD HERSHFIELD (Enrolled Student)

Cooper Union Institute of Technology, New York, N. Y.)

Books Received •

"The Mechanism of the Electric Spark." In this analysis of the present status of the theory of the mechanism of the electric spark in air, L. B. Loeb and J. M. Meek develop a new streamer theory of spark discharge. A general unified theory applicable to various gaps and configurations of electrodes is set forth, from which the methods of computation given enable one to predict in advance the breakdown potential of any spark gap for direct current in the absence of space-charge distortion, and where field distribution in the gap can be calculated. Published by the Stanford University Press, Stanford University, Calif.; 173 pages; price $3.50 per copy.

"The Guntersville Project." This, the fourth in a series of technical reports from the Tennessee Valley Authority, describes the planning, design, and construction of the Guntersville Project on the Tennessee River. The first three reports, which have been reviewed previously are "The Norris Project", 1939 (*EE, Sept. '40, p. 396*), "The Wheeler Project", 1940 (*EE, June '41, p. 310*), and "The Pickwick Landing Project", 1941 (*EE, Aug. '41, p. 418*). As in the other reports, this volume outlines the preliminary social and economic investigations necessary for the project; the designing of locks, dams, and powerhouses; the planning of employee housing, and access roads; methods used in construction and in river diversion; reservoir activities; initial operations; and a summary of construction costs. Appendixes include a statistical summary of the physical features of the project, copies of reports of consulting engineers and geologists, and summaries of special tests. Copies of the 423-page, illustrated report may be obtained from the Treasurer's Office, Knoxville, Tenn., at $1.00 each.

"Results of Municipal Electric Systems." Seventh edition, 1941. This 428-page electric rate book based on reports as to the use and cost of electricity from 758 municipally owned light systems shows that more than half such systems have lowered rates since the 1939 edition of the book, and that a majority of the cities have no bonded indebtedness on their municipal systems. Contained in the book are operating records of earnings, output, rates, revenues, valuation, and also facts pertaining to the increasing use of electricity and the decreasing cost of electricity in municipal installations. Much of the latter information is given in graphs and tables. Copies may be obtained from Burns and McDonnell Engineering Company, Kansas City, Mo., at $5.00 per copy, prepaid.

"Technical Lettering." This book of directions for and exercises in technical lettering, by E. P. de Garmo and Finn Jonassen, aims at enabling the engineer or draftsman to present information clearly and concisely, with as rapid execution as possible. It contains minute instructions as to technique and methods of obtaining the best results. Materials for lettering, proper position of paper and drawing board, and the correct way to hold the drawing instrument are described. Space is provided for practice in lettering. Published by the Macmillan Company, New York, N. Y.; price $1.00.

"How Inventors Can Aid National Defense." This booklet issued by the National Inventors Council (see *EE, Nov. '40, p. 477*) of the United States Department of Commerce, contains information as to the purpose of the Council, the character of potentially useful inventions, and the defense value of inventions. The appendix gives biographical sketches of Council members, technical committees of the Council, suggested procedure for submitting inventions, and a list of literature. Copies of the 22-page report may be obtained from the United States Government Printing Office, Washington, D. C.

"Industrial Health Practices." This report presents a survey of 2,064 industrial establishments compiled by the committee on healthful working conditions of the National Association of Manufacturers, and conducted under the direction of Doctor Victor G. Heiser. It includes information as to the value of a factory health program, physical examination policies in the plants under consideration, representative features of a factory health program, and cost of health programs and length of time that these have been in existence, classified according to size of company and type of industry. Comparisons are made of present status and progress with that noted in earlier reports. Copies of the 76-page illustrated report are available to NAM members and nonprofit organizations at no cost, and to others at 50 cents each. They may be obtained from the National Association of Manufacturers, 14 West 49th Street, New York, N. Y.

"Hotel Engineering. Volume Two, Electric Current Consumption, Cost and Savings." This second book on hotel engineering problems published by the national membership division of the American Hotel Association, and prepared under the supervision of G. C. St. Laurent, contains information on many matters pertaining to electric current consumption, with suggestions as to cutting costs and making savings. Topics discussed in the book include: electric current rates, Diesel engines for hotels, guest room air-conditioning units, fluorescent lighting, electric and gas cooking, economy in lighting, savings on elevator operation, and central cleaning plant and small portable units. Copies may be obtained from the American Hotel Association of the United States and Canada, 221 West 57th Street, New York, at $1.50 per copy.

The following new books are among those recently received at the engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

MANUAL OF ENGINEERING DRAWING FOR STUDENTS AND DRAFTSMEN. By T. E. French. Sixth edition. Revised and enlarged. McGraw-Hill Book Company, New York and London, 1941. 622 pages, illustrated, $9^{1}/_{2}$ by 6 inches, cloth, $3.00. New edition of a standard textbook considerably revised. Page size has been enlarged to allow an increase in the size and number of illustrations; many problems have been changed and added; and in addition to revision of existing chapters new ones have been included on aircraft drawing, jig and fixture drawing and welding drawing. Material conforms to the standards of the American Standards Association. Bibliography of allied subjects.

THE BOULDER CANYON PROJECT, HISTORICAL AND ECONOMIC ASPECTS. By P. L. Kleinsorge. Foreword by E. Jones. Stanford University Press, Stanford University, Calif., 1941. 330 pages, illustrated, $9^{1}/_{2}$ by 6 inches. cloth, $3.50. The whole system of related works comprising the Boulder Canyon Project (not merely the Hoover Dam construction and its resulting reservoir area) is discussed. The history of the project is reviewed, and the economic significance of this flood control, irrigation, power, and water supply system is explained in detail. Geological and engineering aspects of the various dams, canals, and aqueducts are also considered.

AIR RAID PRECAUTIONS (in ten parts), reprinted by permission of the Controller of His Britannic Majesty's Stationery Office. First American edition. Chemical Publishing Company, Brooklyn, N. Y., 1941. Diagrams, etc., 9 by $5^{1}/_{2}$ inches, cloth, $3.00. In the ten separately paged sections of this manual are brought together and amplified the materials published previously in the A.R.P. handbook and memorandum series. Topics discussed include the organization of the air raid wardens' service, communications systems, rescue parties, and clearance and decontamination work; structural defense and window protection; gas detection and identification; training procedures; and the inspection, care, and repair of equipment.

TRANSFORMERS. By E. E. Wild. Blackie and Son, London and Glasgow; Chemical Publishing Company, Brooklyn, N. Y., 1940. 132 pages, diagrams, etc., 9 by 6 inches, fabrikoid, $2.50. One of a series of small volumes dealing with particular sections of electrical engineering. A concise account of the theory, design and operation of transformer types, and a number of worked and unworked examples are presented.